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Ecological DYnamics Simulation Model – Light (EDYS-L)

User's Guide Version 4.6.4

Cade L. Coldren, Terry McLendon, W. Michael Childress, David L. Price, and Mark R. Graves

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Final report

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Abstract: This report describes the Ecological Dynamics Simulation Model – Light model (EDYS-L) in terms of its function and how to use the model software. EDYS-L is designed to mechanistically simulate complex ecological dynamics across spatial scales ranging from square meters to landscape and watershed levels. Modules include climatic simulators, hydrology, soil profile, nutrient and contaminant cycles, plant community dynamics, herbivory, animal dynamics, management activities, and natural/anthropogenic disturbances. Designation of scenarios and management alternatives for each simulation run is conducted within a Microsoft Windows user interface. Outputs include graphical displays in this interface, as well as extensive tabular files for all ecosystem components.

Contents

Figures and Tables

Figures

Tables

Preface

This report provides users with step-by-step instructions for using the Ecological Dynamics Simulation-Light (EDYS-L) software. The guide describes system requirements and instructions for installing and running the software, including developing applications and building datasets, instructions on using the simulation options, and options for managing and displaying output.

This user's guide was prepared by Cade L. Coldren, Terry McLendon, and W. Michael Childress, Raven Enterprises, LLC; and David L. Price and Mark R. Graves, Environmental Laboratory (EL), U.S. Army Engineer Research and Development Center (ERDC). Funding was provided under the System-Wide Water Resources Program (SWWRP). Dr. Steven L. Ashby is program manager for SWWRP.

The report was prepared under the supervision of Dr. Beth Fleming, Director, EL. At the time of publication of this report, COL Kevin J. Wilson was Commander of ERDC, and Dr. Jeffery P. Holland was Director.

Unit Conversion Factors

Multiply	By	To Obtain
acres	4,046.873	square meters
hectares	1.0 E+04	square meters
inches	0.0254	meters
pounds (mass)	0.45359237	kilograms

1 Introduction

The Ecological DYnamics Simulation – Light model (EDYS-L) is a PC-based, mechanistic computer model that simulates ecological responses of soil, plant, and animal components to a wide variety of natural and anthropogenic environmental stressors. It simulates the effects of climatic, hydrological, physiographic, soil, plant, animal, and management variables on growth and production of plants and animals, erosion, and water quantity and quality in both surface and subsurface systems. It is based on the Ecological DYnamics Simulation (EDYS) model, which has successfully simulated a variety of disturbed and natural ecosystems in the United States, Australia, and Indonesia, but is designed as a screening-level tool that may be utilized without extensive training and background education. EDYS-L accomplishes this by using a default suite of plant communities and soils, in contrast to the custom development of site-specific plant communities and soils inherent in a complete EDYS simulation. However, EDYS-L retains the full range of mechanistic processes used by EDYS for conducting ecological simulations.

EDYS-L is designed to simultaneously simulate ecosystem dynamics at three different spatial scales: Plots, Communities, and Landscapes (Figure 1). This approach allows adequate representation of ecological processes that operate at different spatial and temporal scales. Because EDYS uses mechanistic representations of each process at the most appropriate scale, linkages among different components of the community, ecosystem, and landscape can be projected with reasonable confidence.

The Plot Module in EDYS-L simulates ecological mechanisms and dynamics at the small scale (1 m^2 to 1 hectare). Most of the processes in EDYS-L related to plants (e.g., growth, water and nutrient uptake, and competition) and soils (e.g., water and nutrient transport through the profile, decomposition) are implemented in this module (Figure 2). This module is comprised of a number of sub-modules, including Climate, Soil, Hydrologic, Plant, and Animals. Climatic inputs, primarily precipitation and evapotranspiration potential, are based on historical data, stochastically generated, or some combination of both.

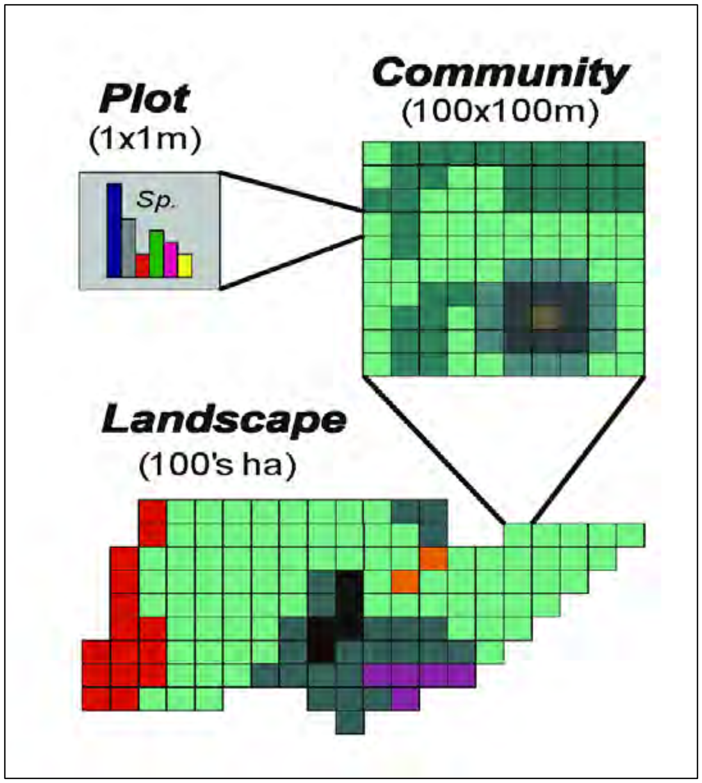


Figure 1. Scaling of the Plot, Community, and Landscape Modules in EDYS-L.

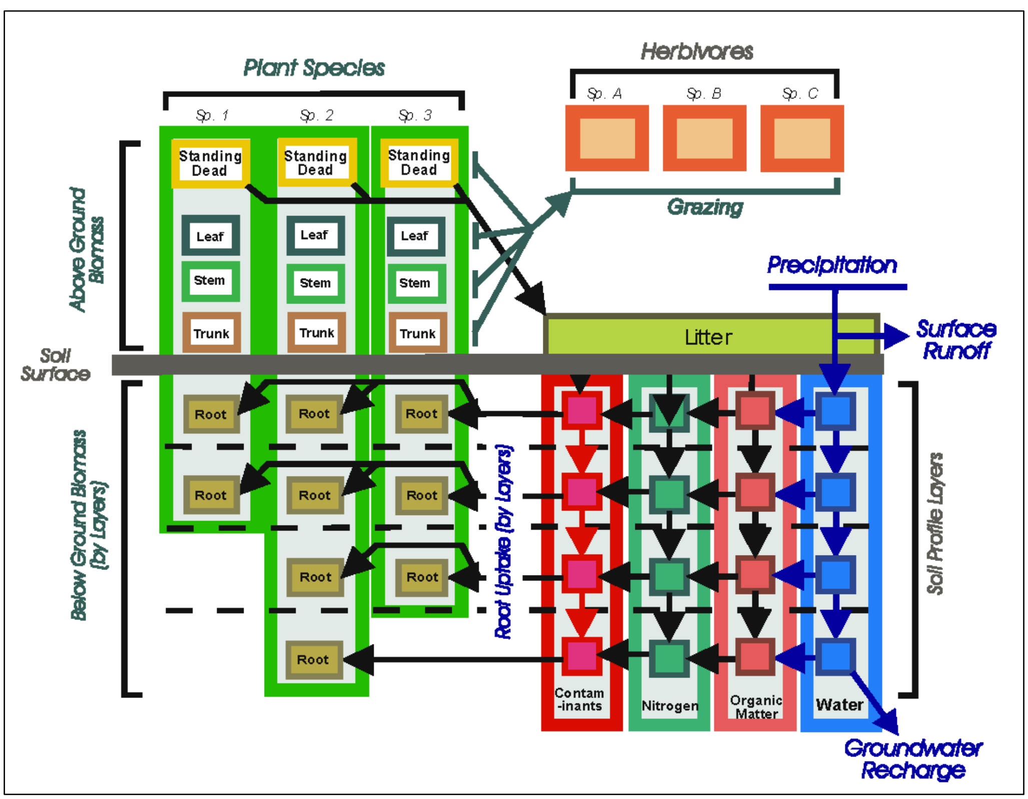


Figure 2. EDYS-L plot-level structure.

The Soil Module represents the soil profile by partitioning it into 20 different layers (horizons, subhorizons, or artificial layers). This representation incorporates the vertical depth, water content and holding capacity, nitrogen content, organic matter content, microbial activity, decomposition, and contaminant content and activity for each layer. The Hydrologic Module simulates small-scale precipitation dynamics, including interception by aboveground plant biomass, surface runoff, erosion and sediment mobilization, infiltration of water through the profile, mobilization and transport of nitrogen, organic matter, and contaminants, and subsurface export of water out of the profile.

The Plant Module represents the dynamics of above- and belowground components for each major plant species. Plant growth is simulated for each component (roots, trunk, stems, leaves, seeds, and standing dead), relative to season, resource requirements (water, nutrients, sunlight), and stressors such as herbivory, competition, fire, trampling, and chemical contaminants. The Animal Module consists of basic population parameters and diet attributes, such as preferences for each plant component (trunk, stems, leaves, standing dead), utilization potential, and competitive success for each specified species (e.g., insects, rodents, native ungulates, livestock, predators).

Plots are represented as cells in the Community Grid (Figure 1). The Community Module focuses on spatial patterns and dynamics from patch to community (1-10 hectares) scales. These include spatial heterogeneity in soils, plants, and stressors among plots within the community, stressors such as fire spread, grazing, and lateral flow of surface water and materials, and important spatial patterns such as vegetation cover, habitats, and topography.

In an analogous manner, communities are the basic units in the Landscape Grid (Figure 1). This largest scale module focuses on ecological processes operating at large spatial scales (1 km^2 and larger). These include fire initiation regimes, climatic regimes, watershed-level water movement and transport of materials, and management practices such as timber harvesting, grazing operations, and weed control.

Each simulation run of EDYS-L produces a large volume of data for all state variables (e.g., plant biomasses, soil water and nutrient contents, total surface runoff) and processes (e.g., water and nutrient transport and

balances, plant production). These data are stored in a series of large text tables, typically on a monthly basis. Many of these data are also presented in graphical displays at the end of the simulation run.

Refer to Childress et al. (1999a,1999b, 2002) and Childress and McLendon (1999) for additional details on EDYS specifications and the range of mechanistic processes simulated. Examples of EDYS applications may be found in McLendon et al. (2000, 2001, 2002a, 2002b); Shepherd Miller, Inc. (2000); Coldren et al. (2001); Price et al. (2004); Johnson and Coldren (2006); and Mata-Gonzalez et al. (2007, 2008). Suggestions for use of the EDYS model in land management may be found in McLendon et al. (1998).

2 System Requirements

2.1 Software and hardware

Minimum recommended system requirements for running EDYS-L on a PC include:

- Microsoft Windows 97, 98, 2000, or XP operating system
- Intel Pentium II processor or better for maximum performance (EDYS-L will run successfully on other processors, but with longer run times.)
- 64 MB RAM (random access memory)
- 750 MB free disk space

2.2 Virtual memory

The virtual memory requirements for running EDYS-L vary depending on the complexity and heterogeneity of the landscape being simulated. A simple landscape may only require 750 MB of free disk space whereas a large, complex landscape could require up to 2 GB of free disk space. Users of EDYS-L on systems running Microsoft Windows 95 or 98 do not need to specify virtual memory settings. Under Microsoft Windows 2000 and XP, the virtual memory settings must be large enough to accommodate the required space. The instructions below specify 750 MB but users requiring more virtual memory are recommended to set the value to 2 GB.

If running Windows 2000, follow these steps:

1. Double-click on the “My Computer” icon.
2. Double-click on the “Control Panel” icon within the “my computer” window.
3. Double-click on the “System” icon within the “control panel” window.
4. In the “System Properties” window, click on the “Performance” tab if running NT or the “Advanced” tab if running 2000.
5. If running 2000, click on the “Performance Options” button.
6. Under “Virtual Memory,” the value listed on the line after “Total paging file size for all disc volumes:” is the current setting for virtual memory. If the amount stated is less than 750 MB, then click on the “Change” button. If the amount stated is 750 MB or more, click on the “Cancel” button at the bottom of the window.

7. If changing, modify the values in the edit boxes next to the labels “Initial Size (MB)” and “Maximum Size (MB)” so that the maximum size is greater than 750 MB. Click on “Set.”
8. Click on “OK,” then close all open windows. The computer will now need to be rebooted to incorporate the new virtual memory settings.

If running Windows XP, follow these steps:

1. Click on the “Start” button in the lower left-hand corner.
2. Click on “Control Panel.”
3. Click on “Performance and Maintenance” within the “Control Panel” window.
4. Click on “System” in the “Performance and Maintenance” window.
5. In the “System Properties” window, click on the “Advanced” tab.
6. In the “Performance” panel, click on the “Settings” button.
7. In the “Performance Options” window, click on the “Advanced” tab.
8. In the “Virtual memory” panel, the value listed on the line after “Total paging file size for all disc volumes:” is the current setting for virtual memory. If the amount stated is less than 750 MB, then click on the “Change” button. If the amount stated is 750 MB or more, click on the “Cancel” button at the bottom of the window.
9. If changing, click on the “Custom size:” radio button, then modify the values in the edit boxes next to the labels “Initial Size (MB)” and “Maximum Size (MB)” so that the maximum size is greater than 750 MB. Click on “Set.”
10. Click on “OK,” then close all open windows. The computer will now need to be rebooted to incorporate the new virtual memory settings.

2.3 Display

To take full advantage of the screen displays in EDYS-L, the computer display should be set for a resolution of 1024x786, true color, and small fonts. To incorporate those settings in Windows 2000, follow these steps:

1. Double-click on the “My Computer” icon.
2. Double-click on the “Control Panel” icon within the “my computer” window.
3. Double-click on the “Display” icon from the “control panel” window.
4. Click on the “Settings” tab within the “display” window.
5. On the “Settings” tab, set the following:

Colors to 'True Color'
Screen Area to '1024 by 768 pixels'

6. Click on "Advanced."
7. On the "advanced" window, change Font Size to 'Small Fonts.'

If running Windows XP:

1. Click on the "Start" button in the lower left-hand corner.
2. Click on "Control Panel."
3. Click on "Appearance and Themes" in the "Control Panel" window.
4. Click on "Display" in the "Appearance and Themes" window.
5. In the "Display Properties" window, click the "Settings" tab.
6. In the "Screen Resolution" panel, move the slider to the '1024 by 768' setting.
7. In the "Display Properties" window, click the "Appearance" tab.
8. Under "Font size:," use the pull-down menu to select the smallest font size.

2.4 Directory structure

EDYS-L is designed to run from any directory on any disc drive. The only requirement is that the input DAT and TXT files are located in a sub-directory called "Data." For example, if EDYS-L is run from d:\EDYS-L\, then the input data must be contained in d:\EDYS-L\Data\. However, several exceptions exist to this structure. If the user has saved a spatial configuration, run options, or initial plant biomasses from a previous simulation run, then these may be loaded from any directory.

By default, output files are written to c:\EDYS-L\Output\. EDYS-L will create this directory automatically if it does not exist. Exceptions to this structure exist. Users may change the output directory and may save their spatial configurations, run options, or initial plant biomasses to any existing directory.

3 Running EDYS-L

3.1 Installing and starting EDYS-L

EDYS-L and its associated data input files are shipped on CD-ROM. Users may run EDYS-L directly from the CD-ROM or may copy all files to their hard drives. If doing so, users need to ensure that the directory structure matches the instructions given above (Section 2.4).

To launch EDYS-L, navigate within Windows Explorer to the directory containing EDYS4.exe. Then simply double-click on the file name.

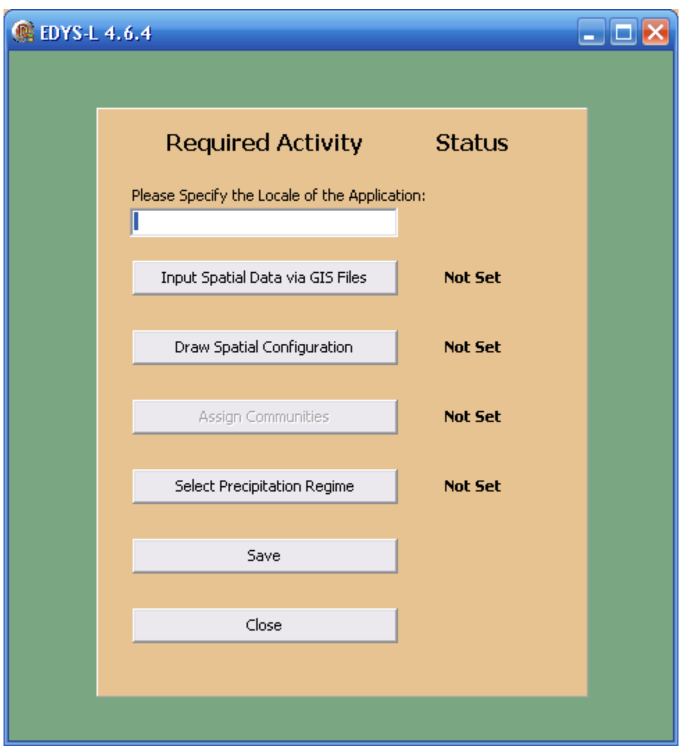
When EDYS-L starts, the following Main Window is displayed. This window allows the user to control the simulation as it proceeds. As such, EDYS-L will return to this window several times during a simulation.

3.2 Building an input dataset

When running EDYS-L, the user must first select the input data before conducting a simulation run. These inputs consist of spatial data, vegetative communities, soils, and climatic data. Each of these is required for a complete simulation dataset, and can be saved by the user to allow multiple runs testing various stressors or management scenarios.

If a dataset for running EDYS-L has previously been built, then it can be selected on the Main Window by clicking the “Input Directory” pull-down menu in the upper-left corner. Click on “Select New” and navigate to the directory containing the dataset for use. Proceed to Section 3.4 of this User’s Manual to continue with the simulation.

If a dataset has not previously been built or a new one needs to be built, click on the “Build” button on the Main Window. The following window (referred to later as the Build Window) will be displayed. It controls the building of a new EDYS-L dataset.



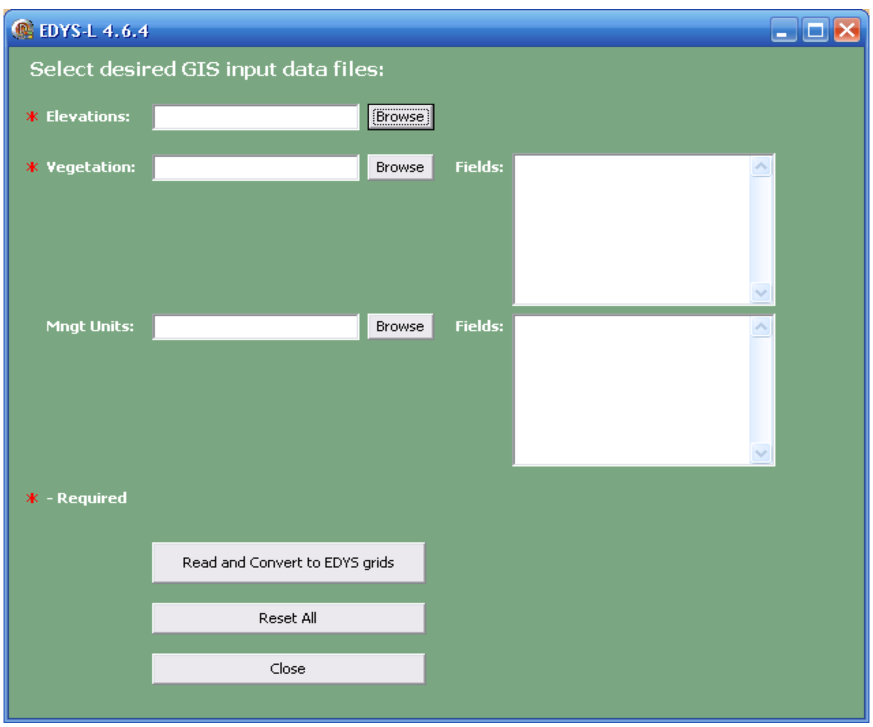
The first step is specifying the locale for this application. It will be displayed on windows during the actual simulation and included in several of the output files.

3.2.1 Spatial inputs

The first step in building the spatial landscape for an EDYS-L application is to determine how the spatial data will be input. This may be accomplished in one of two ways: using GIS files or building the landscape from scratch. The use of GIS files allows the user to simulate a realistic landscape with outputs that can be overlaid over results from other models, e.g., surface runoff models, or that may be used as inputs to those models. Building a landscape from scratch allows the user to quickly evaluate multiple options without expending the time required to develop the appropriate GIS input files.

3.2.1.1 Selecting GIS input files

From the Build Window, click on the "Input Spatial Data via GIS Files" button. The following window will be displayed.



Three input files may be specified, but two of those are required. Elevations and a vegetation map are required while a map of management units is optional. Management units are used to define the spatial extent of land use activities that may occur on more than one vegetative patch. An example is a training area on a military installation. If a management unit map is not specified, those areas are defaulted to coincide with the vegetation map polygons.

All input files are expected to be in the same coordinate system, namely UTM. Future versions of EDYS-L may allow more flexibility in GIS file inputs.

3.2.1.1.1 Elevations

The elevation data are used to set the spatial limits of the EDYS-L simulation run. If the vegetation shapefile is larger than the elevation data file, it will be truncated to match the elevations. Elevation data must be input in ArcGrid ASCII format. An example of this format is as follows:

```
ncols 1853
nrows 897
xllcorner 510376
yllcorner 3276182
cellsize 30
NODATA_value -9999
-9999 -9999 -9999 -9999 604.4 604.3 603.8 ...
-9999 -9999 -9999 599.7 598.6 597.1 594.2 ...
.
.
.
```

Two options exist for selecting the elevation file. The filename, with full directory path, can be entered into the box just to the right of “Elevations.” Or, the browse button to its right may be clicked. This will bring up a standard Windows file dialog box allowing the user to navigate to the appropriate directory and select the desired file.

3.2.1.1.2 Vegetation map

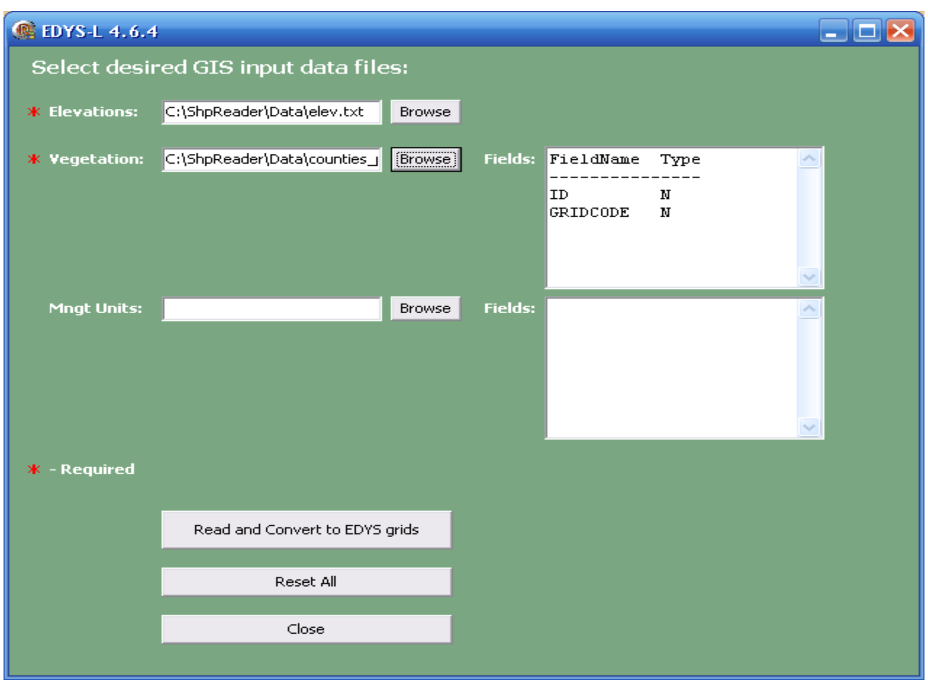
The vegetation map is used to specify the spatial extent and distribution of plant communities throughout the landscape. The composition of the plant community and soil will be determined below in Section 3.2.2.

The vegetation map (and also the management unit map if specified) must be a shapefile containing polygons. Other spatial data types, such as points and polylines, are not allowed. The shapefile must have an associated *.dbf file containing the attribute data. It is preferable for the shapefile to also have an associated projection file (*.prj). EDYS-L can run without this file, but the outputs may not be easily imported into other software packages for viewing, such as the USACE Google Earth server.

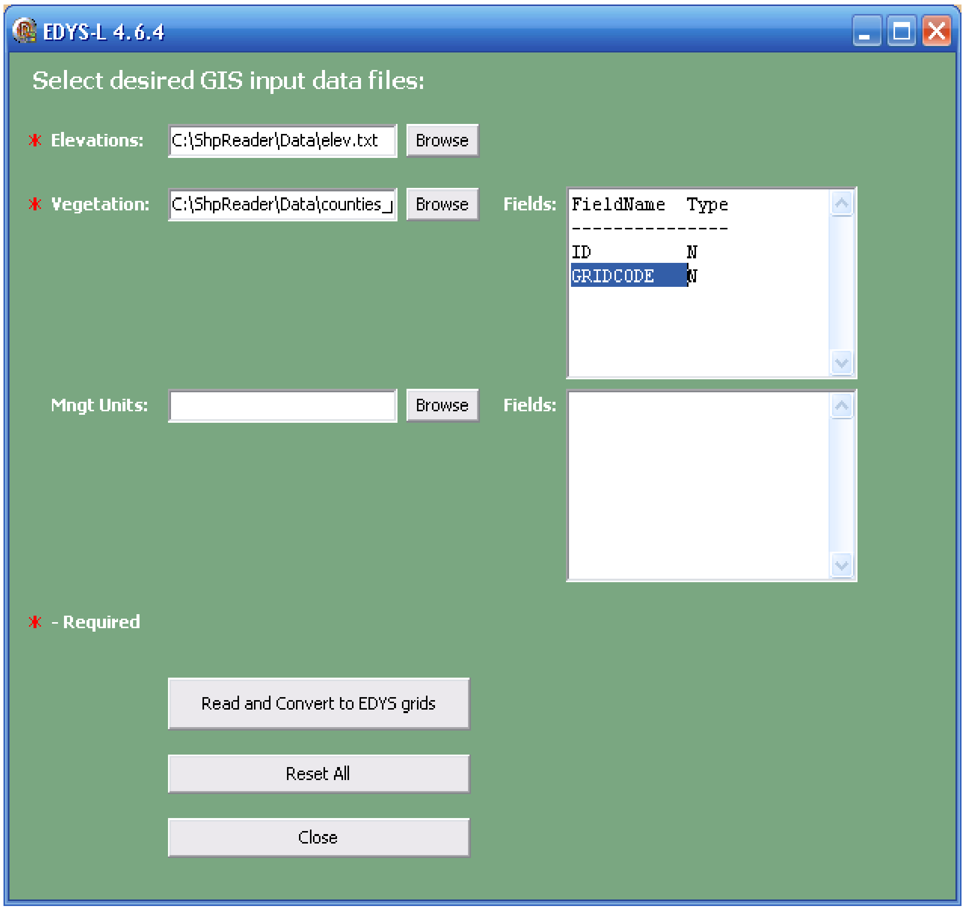
Within the attribute table, one field must be designated to contain a numeric identifier for each polygon. The contents of this field will be used to connect the plant community and soil, as determined below in Section 3.2.2, to the appropriate polygon(s) in the map. The values in this field must be integers. Ideally, they should start at 1, count upward, and end at the total number of polygons. However, in some cases, particularly if the vegetation shapefile is much larger than the elevation map, some polygons may be lost in the truncation process and gaps may appear in the sequencing of polygon numbers. EDYS-L will renumber the polygons internally, but the community names as derived from the *.dbf file contents may not coincide with the polygon numbers. This will become apparent in Section 3.2.2 when the communities are assigned.

Two options exist for selecting the vegetation shapefile. The filename, with full directory path, can be entered into the box just to the right of "Vegetation." Or, the browse button to its right may be clicked. This will bring up a standard Windows file dialog box allowing the user to navigate to the appropriate directory and select the desired file.

Once the vegetation shapefile is selected, its *.dbf file will be read and a list of fields will be displayed in the box to the right of "Fields." This list will contain the name of the field and its type. Valid types may include "C" for text data and "N" for numeric data, as examples. This is shown below:



In this example, the *.dbf file contains only two fields: “ID” and “GRIDCODE.” Both are numeric and each could be used to designate the polygon numbering. Select the appropriate field by double-clicking on its name. The result should look as follows:



3.2.1.1.2 Management units

Management units are used to define the spatial extent of land use activities that may occur on more than one vegetative patch. An example is a training area on a military installation. The management unit shapefile is optional. If it is not specified, those areas are defaulted to coincide with the vegetation map polygons.

The steps for selecting the management unit shapefile are the same as described above for the vegetation map. The same applies for selecting the appropriate field in the management unit *.dbf file.

3.2.1.1.3 Conversion to EDYS-L grids

After the desired input files are selected, clicking the “Read and Convert to EDYS grids” button will convert the vector data contained in the chosen shapefiles to raster data ready for use by EDYS-L for simulations. When the conversion process is complete, this window will close and the user will return to the Build Window.

Several error checks are conducted prior to the conversion process:

- Elevation file has been selected
- Vegetation file has been selected
- Field name has been selected for each shapefile
- The selected field is numeric
- Shapefiles contain polygons

The user will be notified if any of these errors occur, but since none of them are fatal, the user is allowed to correct them by selecting different files or different fields.

3.2.1.2 Draw spatial configuration

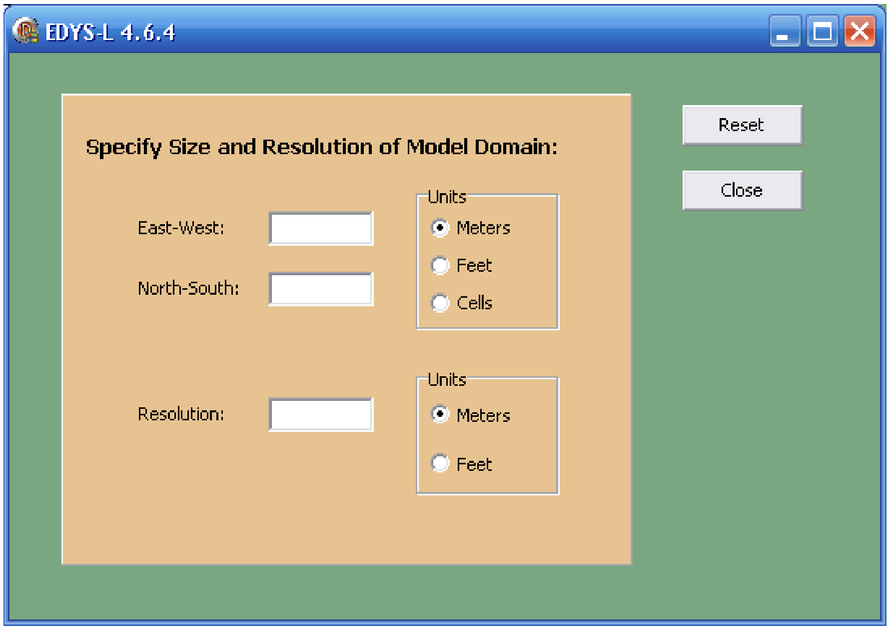
This spatial input option allows the user to build a spatial landscape from scratch, without inputting GIS files. Instead, the user manually, within EDYS-L, builds the landscape to be simulated, specifying the size of the extent, cell resolution, drawing the vegetation map, and building an elevation map.

3.2.1.2.1 Landscape extent

From the Build Window, click on the “Draw Spatial Configuration” button. The following window will be displayed.

Three values must be specified:

- Extent in the East-West direction
- Extent in the North-South direction
- Resolution – this is the size of each individual cell



The settings in the Units boxes control how the specified values for the extent (in both the East-West and North-South direction) are interpreted. For "Meters" or "Feet," the size of the landscape grid will be set as given, while the number of cells will be calculated as the extent divided by the resolution, or cell size. If the extent is given as "Cells," then the number of grid cells in each direction is set as given by the extent, while the size of the grid in each direction is the product of the number of cells and the resolution.

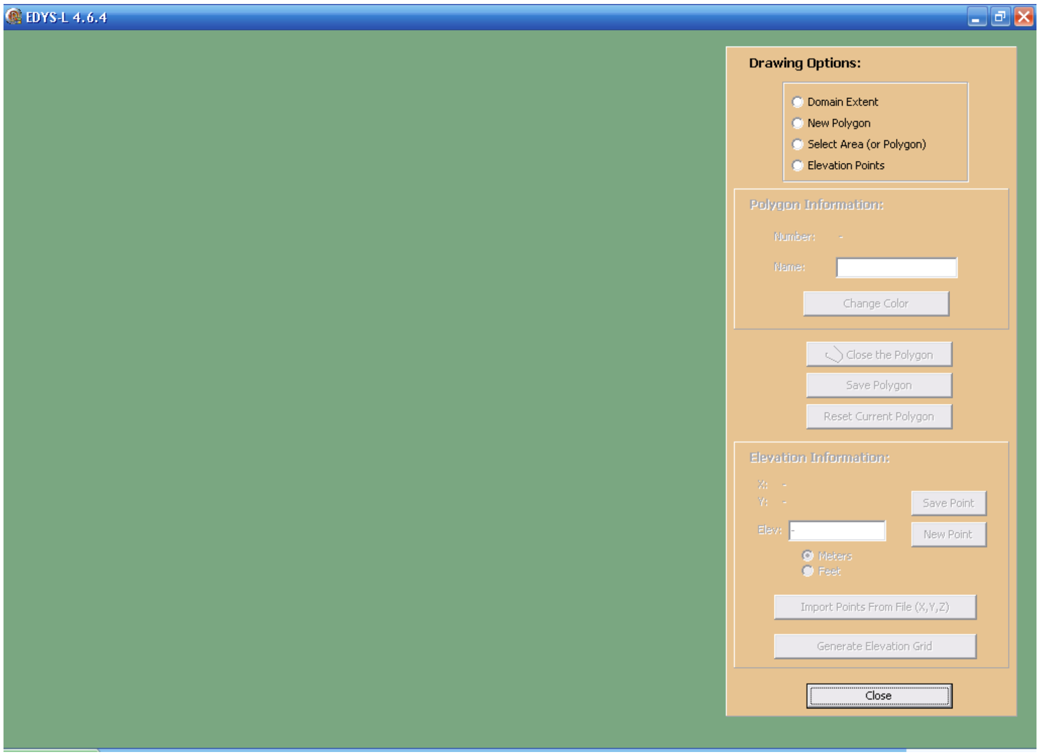
When all values are set, click "Close" to proceed.

3.2.1.2.2 Drawing options

After setting the extent and resolution, the following window will appear:

Four options exist during this step:

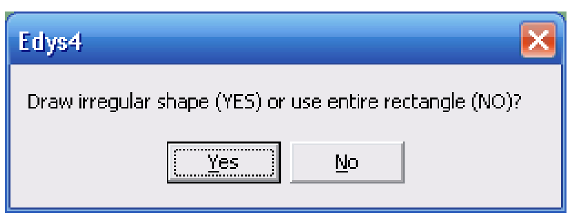
- Domain Extent – either select to use a rectangular shape as specified by the extent and resolution, or draw an irregular shape within the extent specified previously.
- New Polygon – draw new polygons within the domain extent.
- Select Area (or Polygon) – select an area or polygon; used to complete drawing the landscape or to alter the attributes of a polygon.
- Elevation Points – input elevation data for creation of elevation grid.



Each is detailed below.

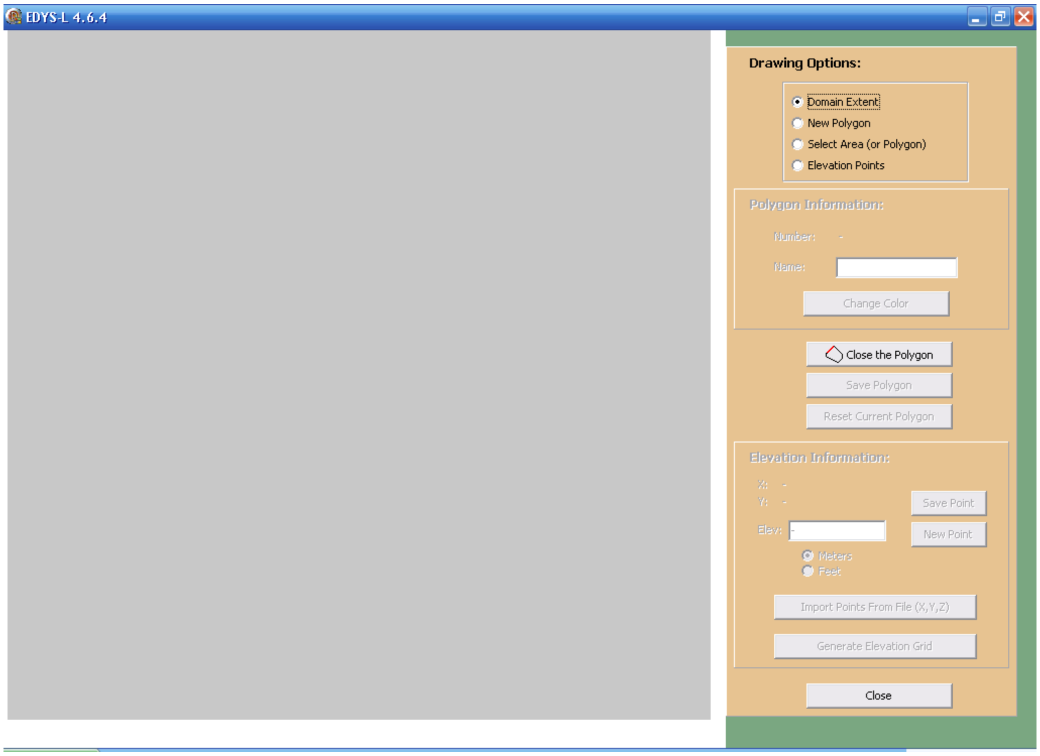
3.2.1.2.2.1 Domain extent

Selecting this option allows the user to determine the shape of the landscape domain, via the following popup form:



Selecting “No” automatically sets the domain as a rectangle based on the values given previously for the extent and resolution. A white rectangle will be drawn on the left portion of the screen. The domain is now ready for polygons to be drawn.

Selecting “Yes” allows the user to draw an irregular shape as the domain extent. A white rectangle will be drawn on the left portion of the screen, with a smaller gray rectangle inset within it.



The cursor, when placed over the white or gray rectangle, is now a cross-hair. Notice also the button to "Close the Polygon" is now enabled. To draw, move the mouse to the desired starting location on the gray rectangle and click the left mouse button. Continue by moving the mouse to the next location and click the left mouse button. The points will be connected by a black line. Continue to the last point prior to closing the polygon. To complete the polygon, click on the "Close the Polygon" button. Click on "Save Polygon" to set this polygon as the domain extent. It will be shown as white on a gray background.

3.2.1.2.2.2 New polygon

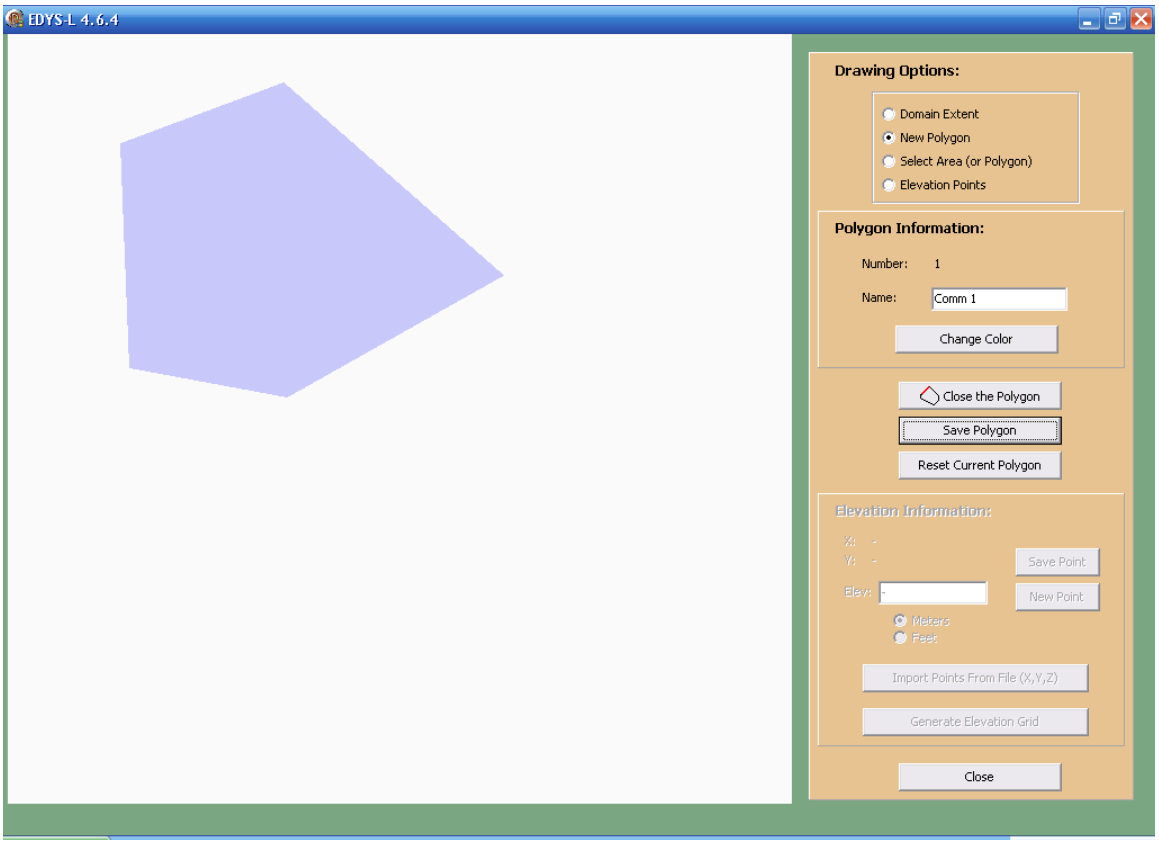
After clicking "New Polygon," the mouse will become a cross-hair when moved over the domain.

To draw a polygon:

1. Click on the starting point (click on the left mouse button).
2. Continue clicking on successive points on the polygon. They will be connected by a black line. Points may fall outside the domain rectangle.
3. To close the polygon, click on the "Close the Polygon" button.
4. Enter the community name to be used for this polygon.

5. Change the color by clicking on the “Change Color” button and selecting the desired color.
6. Click on “Save Polygon.”

An example using one polygon might look as follows:

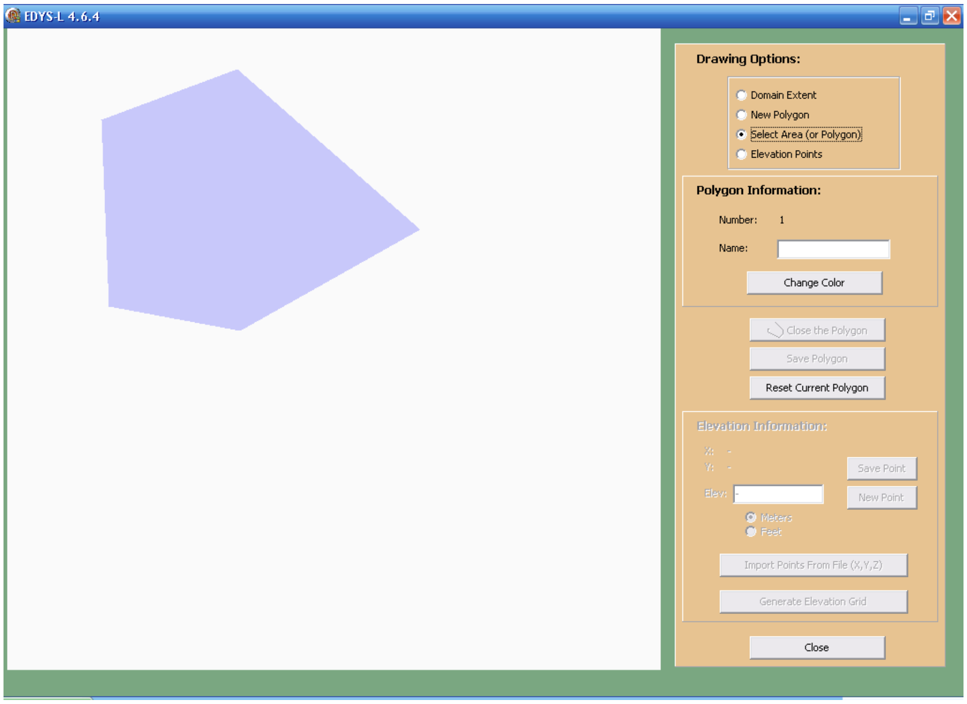


This process may be repeated as needed to complete the landscape. However, to avoid having to match up all points of existing polygons in order to fill the landscape, the “Select Area (or Polygon)” (Section 3.2.1.2.2.3) can be used to complete the landscape by filling in the remaining area as a single polygon.

3.2.1.2.2.3 Select area (or polygon)

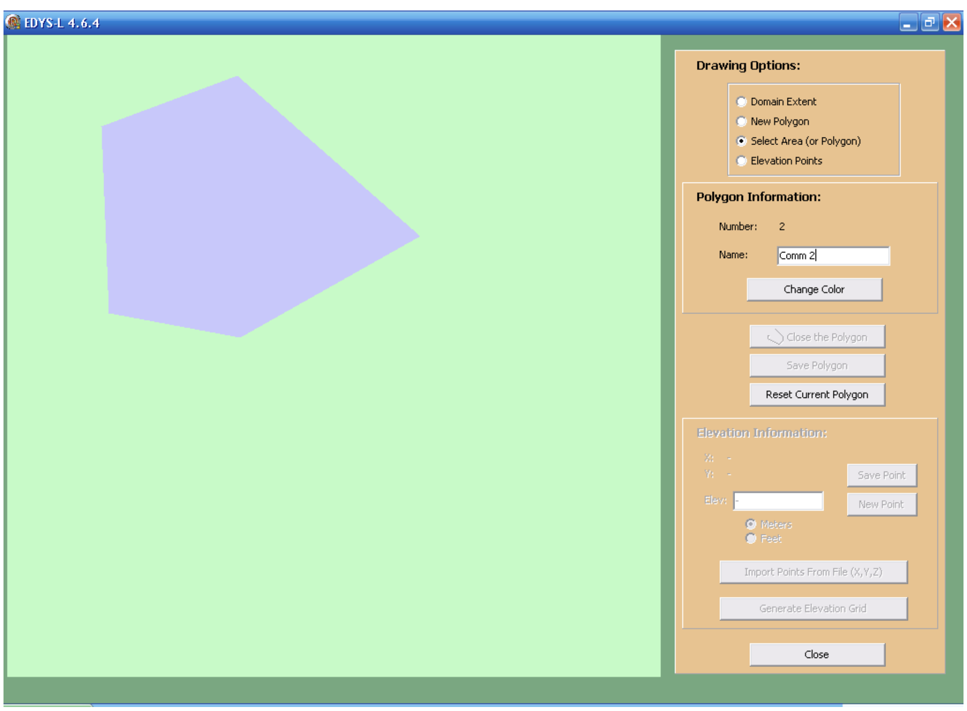
This option allows the user to either designate the remaining landscape as the final polygon or to change the attributes of a previously drawn polygon.

After clicking on this option, the mouse will become a cross-hair when moved over the domain and the screen will appear as this:

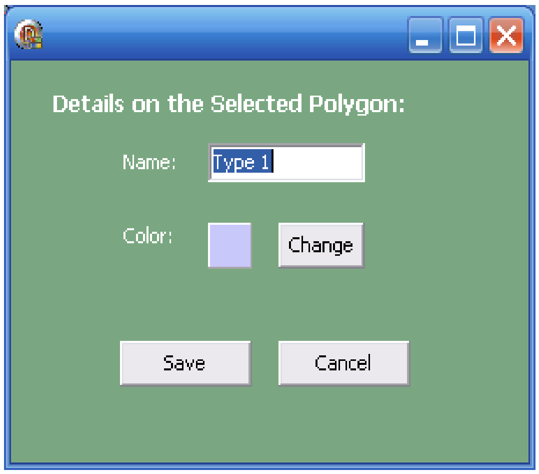


If completing the landscape drawing, follow these steps:

1. Name the community.
2. Click on the white space in the domain. For the example, the result will look like this:

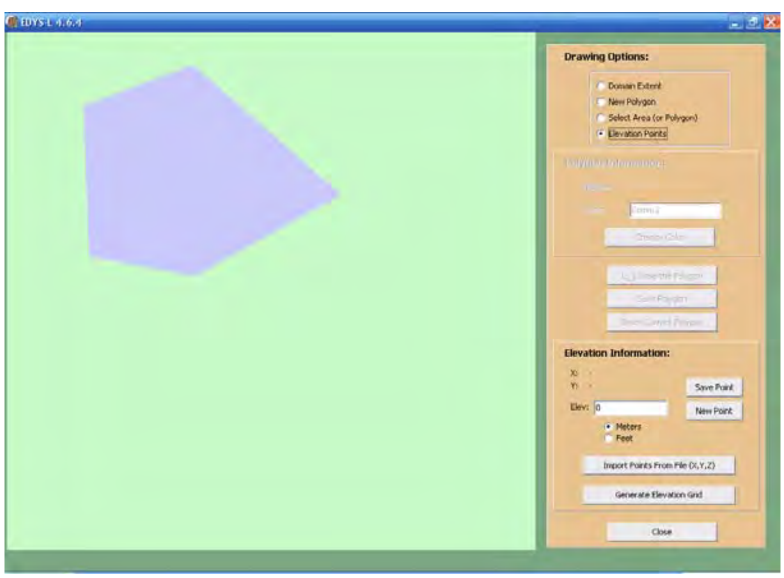


To change the attributes of an existing polygon, move the mouse over the desired polygon and click the left-hand mouse button. The following window will appear. To change the name of the community associated with this polygon, simply type in the new name in the edit box labeled "Name." To change the display color, click the "Change" button and select the desired color. The "Save" button will save any changes, while the "Cancel" button will ignore any changes made on this form and continue using the polygon attributes previously entered.



3.2.1.2.2.4 Elevation points

To build an elevation grid, input multiple elevation points and EDYS-L will use a modified kriging procedure to develop a grid covering the entire landscape. After clicking on "Elevation Points," the screen will appear as this for the example:



To set elevation points, follow these steps:

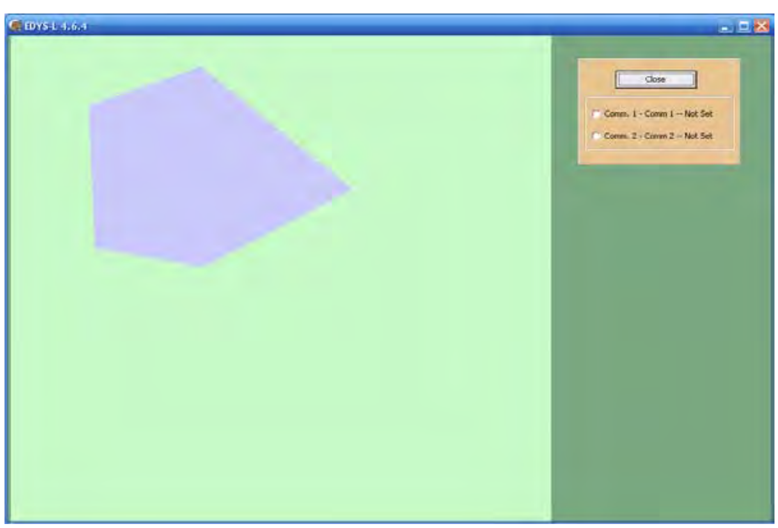
1. Click on the map for the desired location. X and Y coordinates will be displayed under “Elevation Information.” If incorrect, then select a new location on the map.
2. Enter the elevation value.
3. Select the correct units.
4. Click on “Save Point.” A red dot will appear on the map at that location.
5. Click on “New Point” to continue entering points.

When completed entering points, click on “Generate Elevation Grid” to create the elevation grid.

Alternatively, points with corresponding elevational value may be input via a text file. Click on “Import Points From File (X,Y,Z)” to bring up a file dialog and navigate to the desired file. Then select “Generate Elevation Grid” to create the grid. The format of the point file must be “X-coordinate, Y-coordinate, Elevation Value.” The three values must be separated by commas; spaces will be ignored. Each point must be on a separate line. The X- and Y-coordinates must fall within the domain grid. For example, if the grid is 100 cells wide by 100 cells high, then the X- and Y-coordinates must be between 1 and 100.

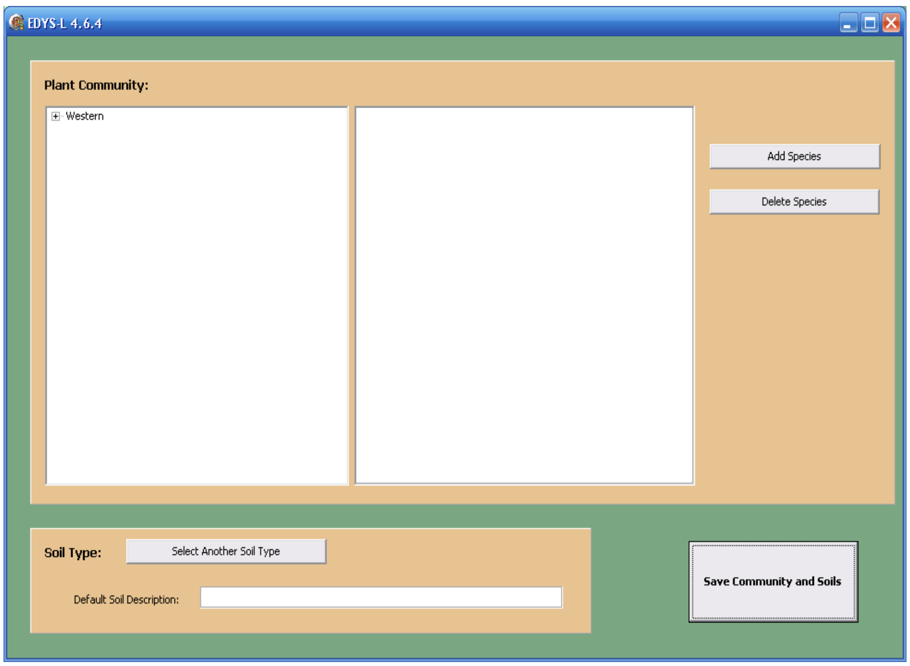
3.2.2 Vegetative communities

After the spatial configuration has been determined, plant communities and soils can now be entered. From the Build Window, select “Assign Communities” and the following window will be displayed.

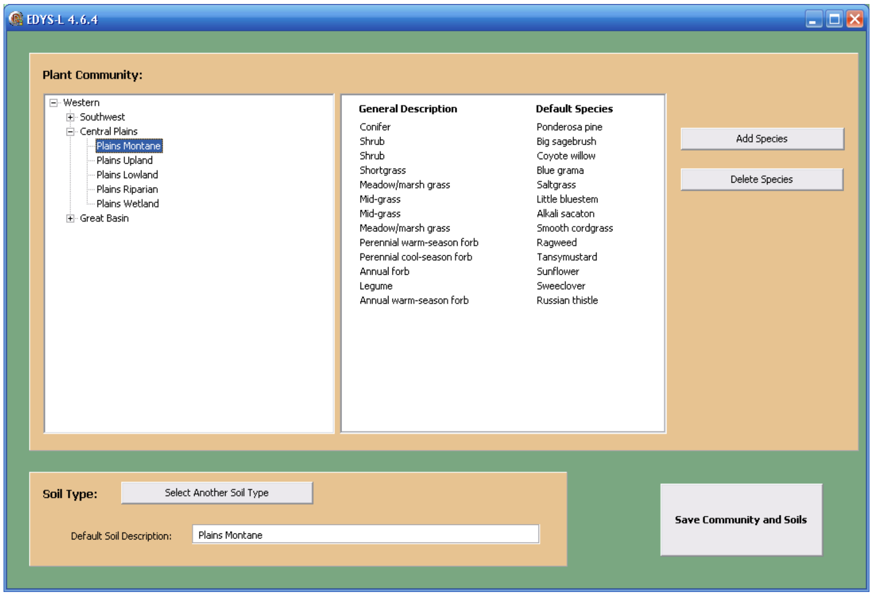


Note the names of the communities listed in the upper right-hand corner. For example, the first community is listed as “Comm. 1 – xxxx – Not Set,” with ‘xxxx’ being the name given to that community when drawing the polygons. If a shapefile is being used for the spatial configuration, then ‘xxxx’ will be of the form “Type yy” with ‘yy’ derived from the sequential numbering system for polygons.

To designate a plant community and soil type, select each polygon one at a time. This can be done either by clicking on a polygon on the map or selecting the appropriate radio button in the upper right-hand corner. The following screen will then be shown.



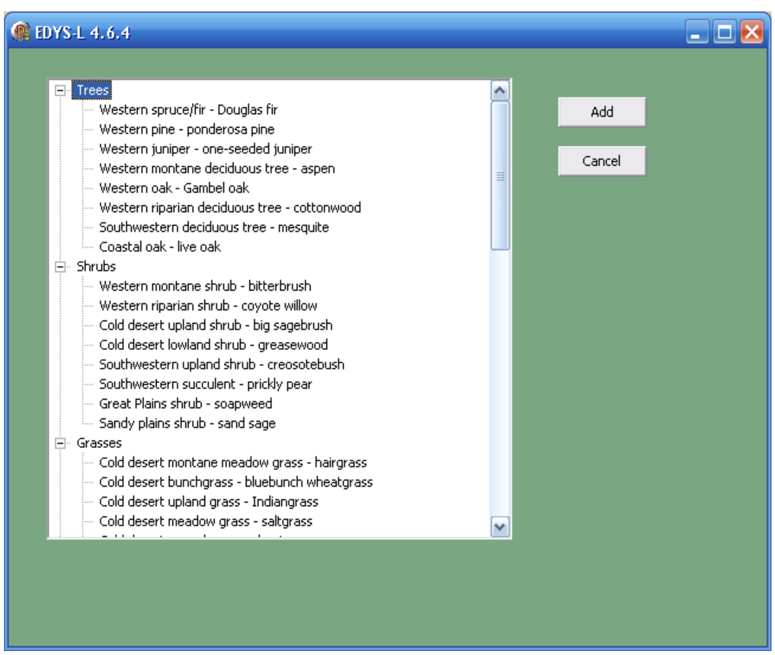
Navigate through the regions and subregions in the left-hand panel to find the desired plant community. Selecting a community will result in the list of default species being displayed in the right-hand panel. All plant communities, default species, and initial biomass values are listed in Appendix A. Additionally, the default soil type will be listed in the bottom panel. Soil characteristics are detailed in Appendix B. One example screen is as follows:



When the desired plant community and soil have been selected, click on "Save Community and Soils." The user will then have the opportunity to complete the plant community and soil assignments.

3.2.2.1 *Adding plant species*

To add species to the list of default species for a community, click on "Add Species" and the following window will be displayed. Select the desired species to add and click on "Add." Flow will return to the above window with the additional species added to the bottom of the default list.



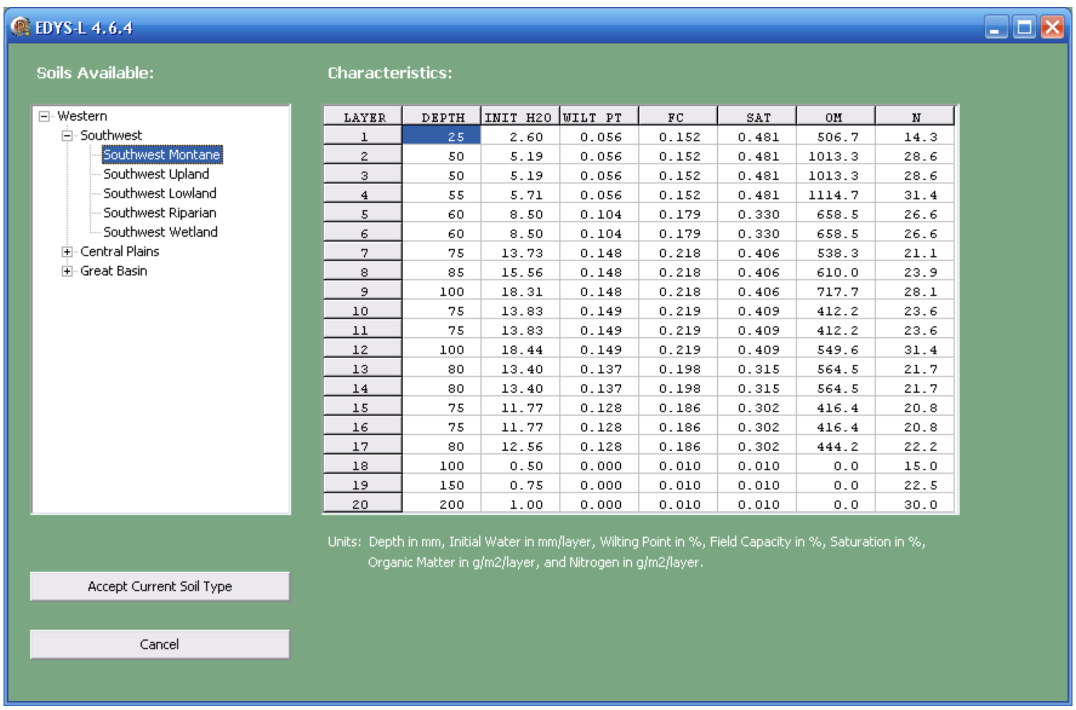
3.2.2.2 Deleting plant species

To delete species from the list of default species, simply highlight the species to be deleted and click on "Delete Species." That species will be removed from the list displayed on the window.

3.2.2.3 Changing soil types

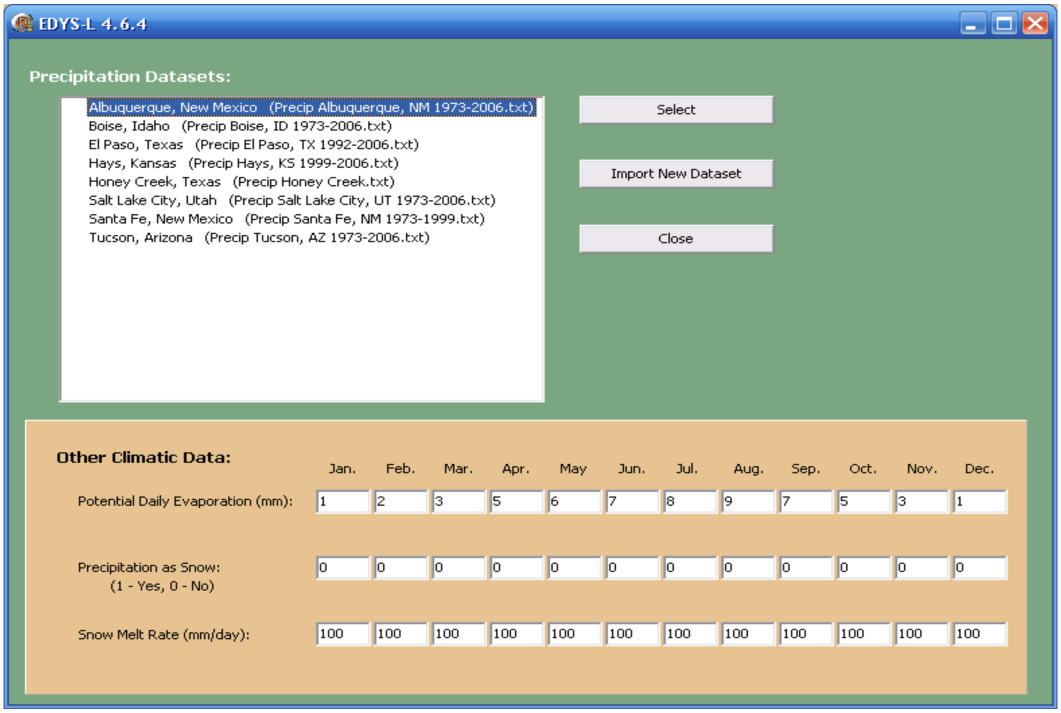
If the default soil is not the desired soil type, click on "Select Another Soil Type" to navigate to the desired soil type. Soil characteristics are displayed to aid the user in selecting the soil with properties most similar to the desired soil. An example follows below.

To use a different soil type, navigate to the desired soil and click on "Accept Current Soil Type." To use the default soil, simply click on "Cancel."



3.2.3 Climatic inputs

Climatic inputs, particularly precipitation, are major drivers influencing vegetation dynamics in a landscape. From the Build Window, click "Select Precipitation Regime" to bring up the following window.

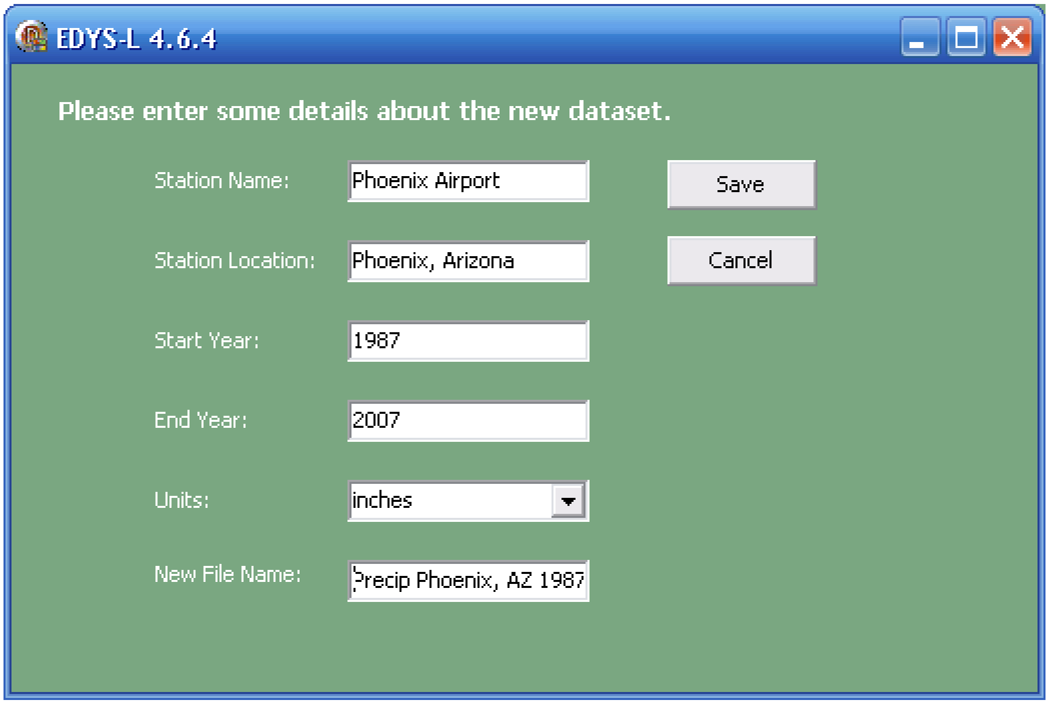


Four datasets need to be input for proper simulation of plant communities within the landscape:

- Precipitation – this is the daily precipitation pattern to be used throughout the landscape
- Potential Daily Evaporation – daily maximum possible evaporation rates by month (in mm)
- Precipitation as Snow – months in which precipitation falls as snow (1 for snow months, 0 for rain months)
- Snow Melt Rate – daily rate of snow melt (in mm/day)

The list of available precipitation datasets will be shown in the panel on the left-hand side of the window under the heading "Precipitation Datasets." For each location, the associated filename is shown. Part of the filename is the range in years encompassed within the dataset so as to aid the user in selecting the appropriate dataset for use. To select one, highlight the desired dataset and click "Select."

New precipitation datasets may be added to the default list. Click on "Import New Dataset" and navigate to the file containing the precipitation data. The following window will then be displayed, allowing the user to designate information about the dataset.



The input data file must be built in the following format (year, month, number of days in the month, day 1, day 2, ...) prior to importing:

```
1987 , 1 , 31 , 0.00 , 0.00 , 0.00 , 0.01 , 0.12 ...
1987 , 2 , 28 , 0.04 , 0.00 , 0.00 , 0.00 , 0.00 ...
1987 , 3 , 31 , 0.12 , 0.00 , 0.00 , 0.01 , 0.00 ...
1987 , 4 , 30 , 0.00 , 0.08 , 0.00 , 0.00 , 0.00 ...
1987 , 5 , 31 , 0.04 , 0.00 , 0.00 , 0.00 , 0.06 ...
1987 , 6 , 30 , 0.02 , 0.04 , 0.00 , 0.00 , 0.00 ...
1987 , 7 , 31 , 0.63 , 0.63 , 0.00 , 0.00 , 0.00 ...
1987 , 8 , 31 , 0.08 , 0.00 , 0.01 , 0.00 , 0.63 ...
1987 , 9 , 30 , 0.00 , 0.00 , 0.00 , 0.00 , 0.00 ...
1987 , 10 , 31 , 0.00 , 0.00 , 0.00 , 0.00 , 0.08 ...
1987 , 11 , 30 , 0.00 , 0.00 , 0.08 , 0.00 , 0.00 ...
1987 , 12 , 31 , 0.00 , 0.00 , 0.04 , 0.00 , 0.00 ...
1988 , 1 , 31 , 0.08 , 0.12 , 0.00 , 0.00 , 0.00 ...
1988 , 2 , 28 , 0.59 , 0.59 , 0.47 , 0.51 , 0.00 ...
1988 , 3 , 31 , 0.35 , 0.00 , 0.36 , 0.28 , 0.00 ...
...
```

EDYS-L will create a new precipitation data file using the information entered above and the daily precipitation data. The list of available precipitation data files will be updated to include the new file. The output file will have this format:

```
{Phoenix, Arizona}
{Phoenix Airport}
{21 years; Start - 1987, End - 2007}
{Units: in}
1987 , 1 , 31 , 0.00 , 0.00 , 0.00 , 0.01 , 0.12 ...
1987 , 2 , 28 , 0.04 , 0.00 , 0.00 , 0.00 , 0.00 ...
1987 , 3 , 31 , 0.12 , 0.00 , 0.00 , 0.01 , 0.00 ...
...
```

3.2.4 Saving input data

The last step in specifying the input dataset for use with EDYS-L is to save the selected data to appropriate files. From the Build Window, select “Save.” Navigate to the desired directory location to store the data files. This allows the user to build a dataset once and run multiple scenarios evaluating various management activities and stressors.

3.3 Main window

The Main Window, shown above in Section 3.1, controls the flow of events during an EDYS-L run. All of the windows described below eventually return control of EDYS-L back to this form. Seven buttons are displayed, but not all are active at all times. By enabling and disabling buttons during the course of a simulation, EDYS-L controls which steps can logically be taken and which ones cannot. For example, before a simulation is actually run, the results display button is disabled since no results are available to be displayed.

The following buttons are displayed on the Main Window:

Build Guides the user in building an input dataset.

Options Allows the user to select options for a particular EDYS-L simulation run.

Activities Allows the user to select any natural resource management activities, like brush management and prescribed fire, and to select any herbivory, if appropriate for the application.

Run Takes the user to a window to begin the EDYS-L simulation run and allows the user to monitor the run.

Results Directs flow of EDYS-L to a results display window so the user may view graphs and plots of the results of the current EDYS-L simulation.

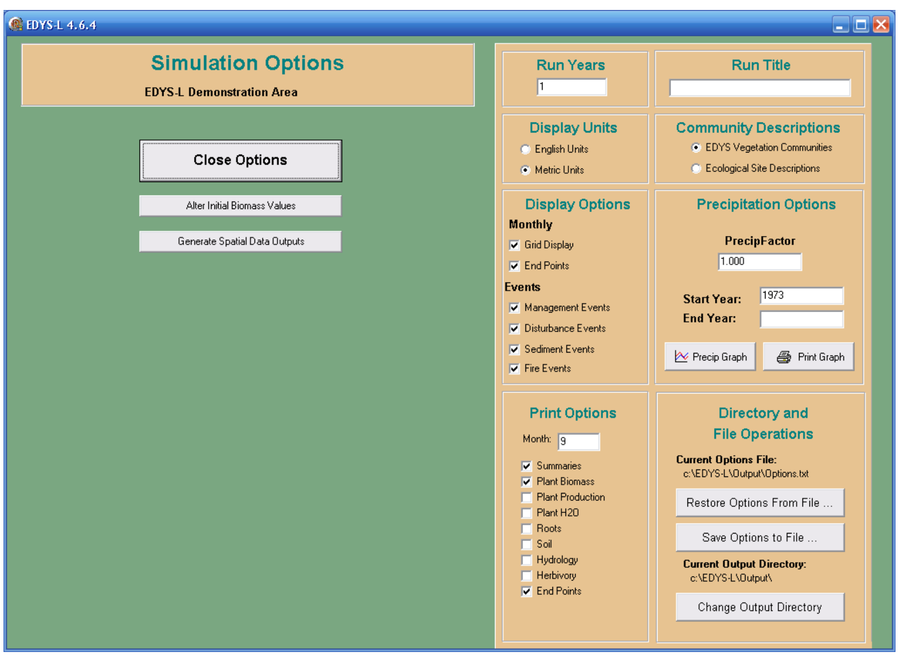
Reset Resets EDYS-L for another simulation run. All matrices and grids are returned to their original values, and options and management activities are cleared.

Close Causes EDYS-L to exit.

After selecting or building a new input dataset, the normal flow of events during an EDYS-L simulation run continues with setting the Options. This step is required. Next, any natural resource management activities or herbivory to occur during the simulation must be determined and set. After setting the activities, go to the Run Display Window to actually conduct the simulation run. Once the run has completed, go to the Results Display Window to view the results of the run. This step is optional because many of the output variables are written to text files during the run. If desired, these text files may be accessed with a word processor or spreadsheet package without visually displaying the results.

3.4 Simulation options

The Options Window allows the user to select or deselect any of a variety of simulation control options.



Three main buttons are available to the user:

Close Options	Exit the Options Window and return to the Main Window.
Alter Initial Biomass Values	Allows the user to change initial plant biomass values. Details are given below (Section 3.4.1).
Generate Spatial Data Outputs	Allows the user to specify the details of spatial data outputs, including timing, format, and which EDYS-L variables to output. Details are given below (Section 3.4.2).

Simulation control options, displays, and file outputs are grouped together on the window by functionality. Details on each option are given below.

Run years Set the number of simulation years for EDYS-L to run. Enter the number of years as a positive integer value into the box below the heading "Run Years." The default is one year.

Run title Set a title for each simulation run to aid the user in identifying the files associated with each run. It is included in all of the output files except the spatial outputs (these files have strict formats).

Display units

English Units Set the display and output units to be English. For example, biomasses are expressed in lbs/acre, and water volume in acre-feet.

Metric Units Set the display and output units to be Metric. For example, biomasses are expressed in g/m^2 while water volume is expressed in m^3.

Community descriptions

EDYS vegetation communities

Set the display and output communities to be those used internally within the EDYS-L simulation, as specified when building the spatial dataset. This is the default.

Ecological site descriptions
Set the display and output communities to correspond to NRCS Ecological Site Descriptions. This option is for advanced users only.

Display options

Grid display	Display the vegetation grid during the simulation run.
End points	Display any end point values during the run.
Management events	Display the spatial extent of management activities during the run. The disturbed areas are illustrated as red on the vegetation grid.
Disturbance events	Display the spatial extent of disturbance activities during the run. The disturbed areas are illustrated as red on the vegetation grid.
Sediment events	Display the sediment and water grids during a runoff event. The sediment grid shows cells that lose soil (displayed as red) and cells gaining sediment (displayed as blue). The water grid shows the flow of water across the landscape during the runoff event. The intensity of blue represents the amount of water moving between cells. Dark blue corresponds to a greater amount of water than light blue.
Fire events	Display the spatial extent of a fire, shown as red on the vegetation grid.

Print Options

Month	This option determines in which month certain biomass data are output. This value is an integer corresponding to the number of the

month (January is 1 and September is 9, for example). Usually, this value is set to the month corresponding to the end of the growing season at the specific location being simulated.

Summaries	This option builds several files containing summary information from the run. The file “Avg Biomass across the Landscape.txt” contains average biomasses for every species. Values are weighted by plot type abundances within the landscape. The files “Landscape Hydrology Totals.txt” and “Landscape Plot Hydrology.csv” contain hydrological totals by plot type and summed across the landscape. The file “Spatial Statistics.txt” contains some basic spatial information, including mean and standard deviation for patch sizes by plot types. All files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.
Plant biomass	This option builds a number of files containing plant biomasses. Five sets of files are generated. In all file names, ‘yyyy’ is the community name and ‘xx’ is the community number, both of which were specified while building the spatial dataset. The files named “Total Biomass in yyyy, Comm xx.txt” contain total living plant biomasses. The files named “AboveGround Biomass in yyyy, Comm xx.txt” contain total aboveground plant biomasses. The files named “Clippable Biomass in yyyy, Comm xx.txt” contain total clippable plant biomasses. The files named “Live Clippable Biomass in yyyy, Comm xx.txt” contain living clippable biomasses. The files named “Leaf Biomass in yyyy, Comm xx.txt” contain only leaf biomasses. All files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

Plant production	This option builds files of monthly plant production. The files are named “Plant Production for yyyy, Comm xx.txt” where ‘yyyy’ is the community name and ‘xx’ is the community number as determined during creation of the spatial dataset. All files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.
Plant H_2O	This option builds files of monthly plant water uptake. These files are named “Plant Water Use for yyyy, Comm xx.txt” where ‘yyyy’ is the community name and ‘xx’ is the community number as determined during creation of the spatial dataset. All files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.
Roots	This option builds three sets of files detailing monthly root biomasses by soil layer. The files named “Root Biomass for yyyy, Comm xx.txt” contain total biomasses for all adult plants. The files “Seedling Root Biomass for yyyy, Comm xx.txt” contain total biomasses for seedlings. The files named “Root Component Biomass for yyyy, Comm xx.txt” contain adult root biomasses broken out by coarse roots and fine roots. For all files, ‘yyyy’ is the community name and ‘xx’ is the community number as determined during creation of the spatial dataset. All files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.
Soil	This option builds “Soil Totals.txt,” which contains monthly totals by layer for soil depth, water, organic matter, and nitrogen content. This file is “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

Hydrology This option builds “Daily Plot Hydrology.txt,” which contains daily values for water budgets. Values are output to this option only on days when precipitation occurs. “Monthly Plot Hydrology.txt” contains monthly values for water budgets. The file “Water Uptake by Layer.txt” contains monthly water uptake by layer. These files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

Herbivory This option creates several files containing monthly consumption by each herbivore, listed by plant species. Files named “Herbivory Totals for xxxxxxxx.txt” contain the data for each herbivore species separately, with ‘xxxxxxxx’ being the herbivore’s name. Also, the file “Herbivory Totals.csv” contains all the consumption data in one file. These files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

End points Selecting this option generates any application-defined end point variables. Filenames will always begin with “EP.” These files are “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

Precipitation options

Precip factor Alters the precipitation regime for this EDYS-L run. Values may be any positive real number and are multiplied by each daily precipitation amount. Normal precipitation uses a value of 1.00. A wet cycle of a 25% increase would use a value of 1.25, while a drought 75% of normal would use a value of 0.75. Default is 1.00.

Start year If the user knows a particular historical precipitation regime to use, the starting year of the desired sequence should be entered. The

default is the starting year of the precipitation file specified when building the input dataset.

End year — If the user knows the end of a particular historical precipitation regime to use, the ending year of the desired sequence should be entered. The default is the final year contained in the precipitation file specified when building the input dataset.

Precip graph — Clicking this button shows a graph of annual precipitation totals for the entire period of record contained in the precipitation file.

Print graph — This button allows the user to print the precipitation graph.

Directory and file operations

Save options to file …

By default, options are saved in the file Options.txt in the output directory. However, if the user desires, the file name and directory can be changed. Click on the *Save Options to File …* button to show a file dialog window. Navigate within this window to the desired directory and set the desired file name. Note: the save operation does not take place until the user goes to the Run Display Window. This gives the user the ability to set management activities and save them in the options file.

Restore options from file …

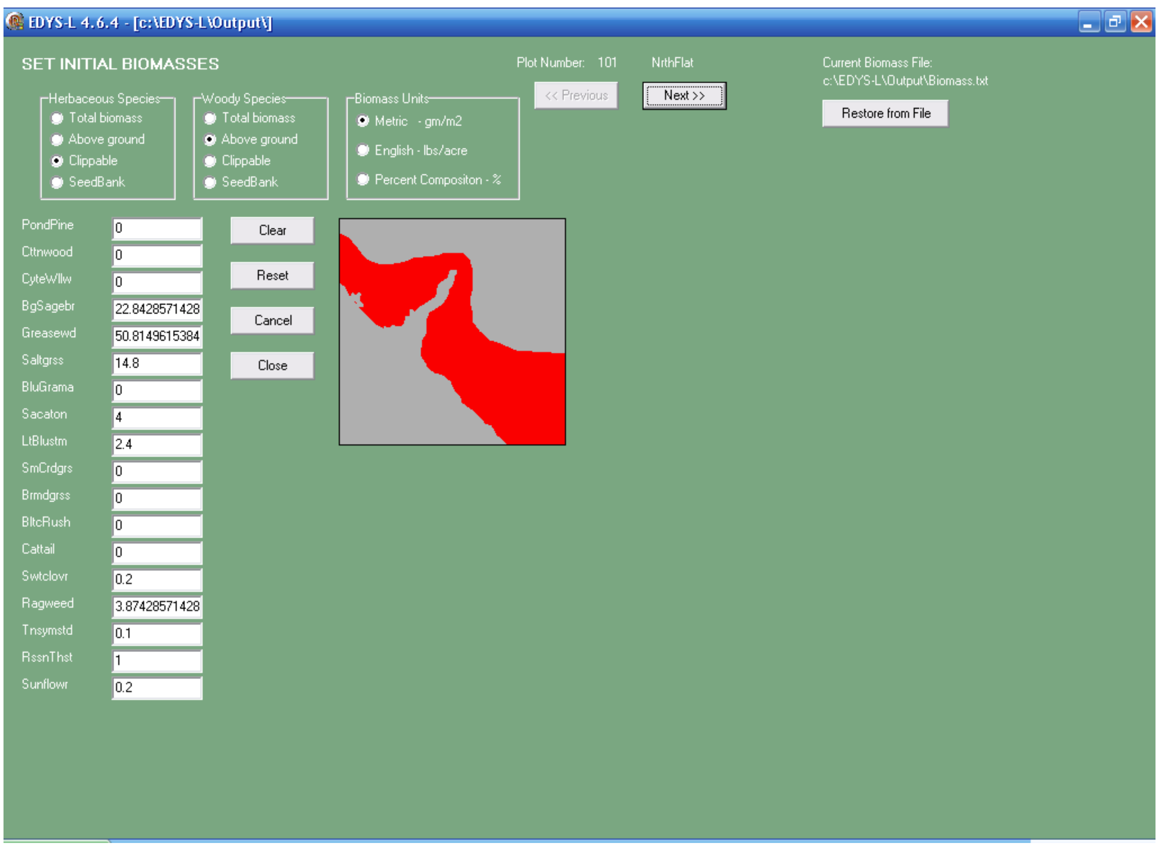
Option settings from previous runs can be accessed to facilitate running multiple complex scenarios. To select an options file from a prior run, click on the *Restore Options From File …* button. This will pull up a form that allows the user to navigate to the desired directory and options file.

Change output directory

By default, all output files are located on C:\EDYS-L\Output. To change the output directory, click on the Change *Output Directory* button. A window will appear that allows the user to navigate to the desired output directory.

3.4.1 Alter initial biomasses

This window allows the user to run EDYS-L with initial plant biomass values differing from those contained in the input DAT files. Values can be input for each species for each plot type. However, the user cannot add species or plot types.



Initial biomasses may be altered using the boxes next to each plant species on the left-hand portion of the form. Three groups of radio buttons allow the user to select the format for those values. Biomass totals can be displayed and input as either total biomass, aboveground biomass (trunk, stems, leaves, seeds, standing dead stems, standing dead leaves, and

seedling shoots), clippable biomass (stems, leaves, seeds, standing dead stems, standing dead leaves, and seedling shoots), and seed bank. Select the appropriate total to use when displaying and altering. Separate sets of radio buttons are available for herbaceous species and woody species. The units for the values displayed and input can be set to either metric (g/m^2), English (lb/acre), or percent composition (%). A series of buttons allows the user to navigate between plot types, the spatial distribution of which is shown in red on the grid, and to set the values:

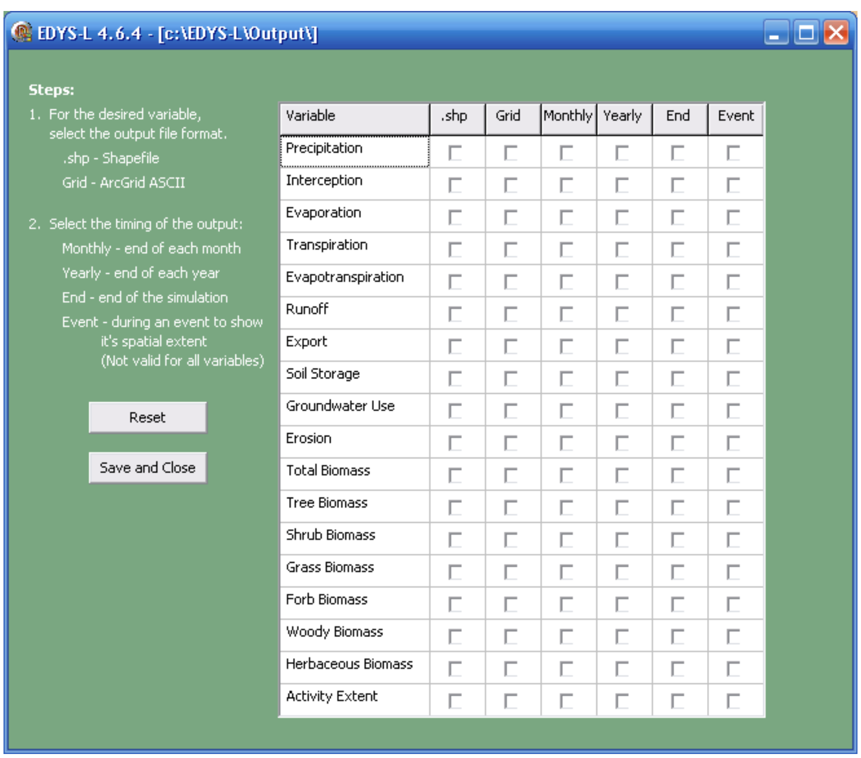
Restore from file	This button allows the user to input a previously saved set of biomass values. Clicking this button pulls up a file dialog window to allow the user to navigate to the appropriate file. After restoring values from a file, the user may now alter any of these and then save to another file. In this way, a variety of initial conditions may be created by the user. This gives the user the flexibility to test scenarios with varying initial conditions, or to repeatedly update initial conditions as knowledge of the landscape condition changes over time.
Previous	Displays values for the previous plot type. This button is disabled when the first plot type is displayed (the default condition upon entry to this form). In combination with the "Next" button, the "Previous" button allows the user to move through all plot types and go back and forth between plot types if needed.
Next	Displays values for the next plot type in the sequence. This button is disabled when the last plot type is displayed. In combination with the "Previous" button, the "Next" button allows the user to move through all plot types and to go back and forth between plot types if needed.
Clear	Sets all displayed values to zero.
Reset	Sets all displayed values back to the default initial biomasses.

Cancel Closes the form without using or saving any altered values.

Close Sets all input values to the appropriate data structures for the simulation run, and gives the user the option of saving the new values to a file for later use. If the user desires to save the values, a file dialog window will appear to allow navigation to the desired directory and file. The default file name is Biomass.txt in the output directory. If the file already exists, the user will be prompted to overwrite or to select a new file name.

3.4.2 Generate spatial data outputs

This window, as shown below, allows the user to generate output files containing the spatial distribution of a variety of variables simulated by EDYS-L. The user may select multiple variables for a single simulation, multiple formats, and a variety of timings. They may be combined as needed; none are mutually exclusive of any others. Output files can be animated using the CorpsGlobe Model Animation Creation Application or 'AnimateKMZ' software, documented in Appendix C. The software can be downloaded from the specified link in the documentation.



Spatial data may be output in two different file formats:

- .shp – Shapefiles
- Grid – ArcGrid ASCII format (see Section 3.2.1.1.1. “Elevations” for an example)

and at different intervals during the simulation:

- Monthly – output at the end of each simulation month
- Yearly – output at the end of each simulation year
- End – output only at the conclusion of the simulation
- Event – output during a management activity or disturbance such as fire

The following variables may be output:

Precipitation	Total precipitation, including rainfall and snow, over the selected time interval (in mm or inches).
Interception	Total moisture intercepted by plant leaves (in mm or inches).
Evaporation	Total moisture evaporated from the soil surface (in mm or inches).
Transpiration	Total water use by plants (in mm or inches).
Evapotranspiration	Total water evaporated from the soil surface added to the water used by plants (in mm or inches).
Runoff	Total rainfall moving across the soil surface in rainfall events (in mm or inches).
Export	Total water that percolated below the rooting zone of the plants (in mm or inches).
Soil storage	Total moisture stored in the soil profile (in mm or inches).
Groundwater use	Total water use by plants that was derived from groundwater (in mm or inches).

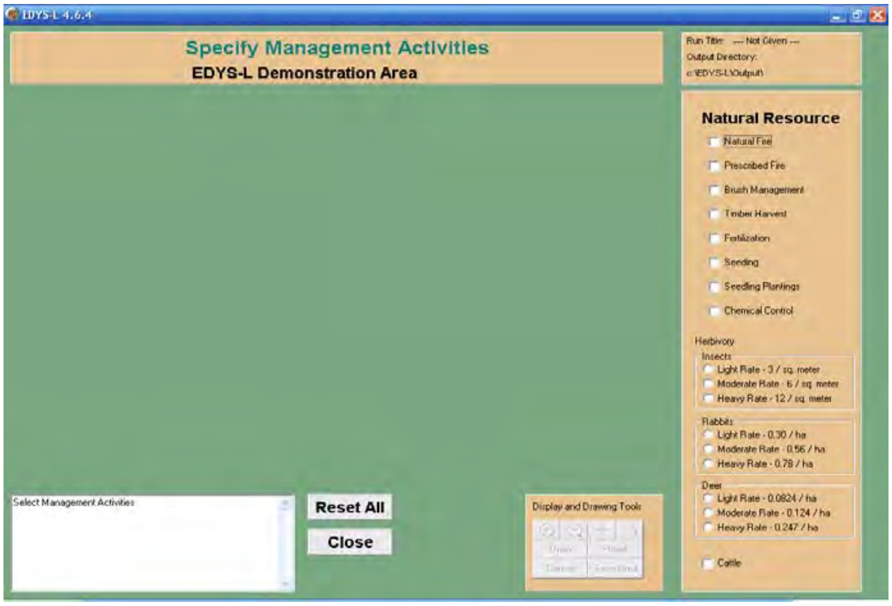
Erosion	Total amounts of erosion or deposition occurring from rainfall events (in mm or inches).
Total biomass	Total aboveground biomass of all species (in g/m^2 or lb/acre).
Tree biomass	Total aboveground biomass of all tree species (in g/m^2 or lb/acre).
Shrub biomass	Total aboveground biomass of all shrubs (in g/m^2 or lb/acre).
Grass biomass	Total aboveground biomass of all grasses (in g/m^2 or lb/acre).
Forb biomass	Total aboveground biomass of all forbs (in g/m^2 or lb/acre).
Woody biomass	Total aboveground biomass of all woody species, including both trees and shrubs (in g/m^2 or lb/acre).
Herbaceous biomass	Total aboveground biomass of all herbaceous species, including both grasses and forbs (in g/m^2 or lb/acre).
Activity extent	Spatial extent of a management activity or disturbance. Disturbed cells or polygons have an attribute value of 1, while undisturbed cells or polygons have a value of 0.

3.5 Management activities

The Activities Window allows the user to input all desired natural resource management activities and herbivory for the simulation run.

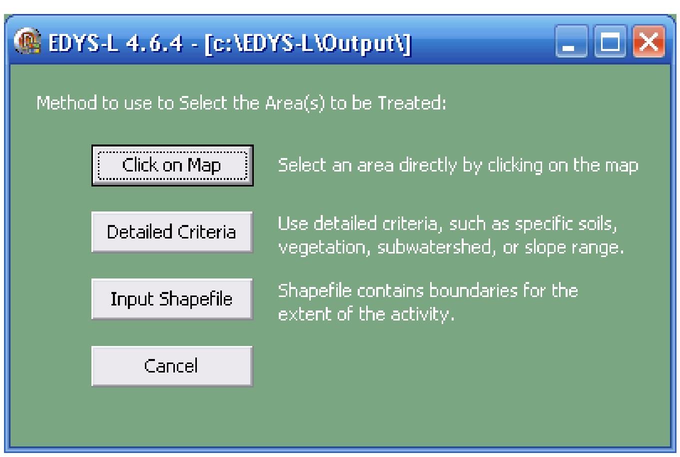
The panel on the right-hand side lists the full range of management activities supported in EDYS-L. The window is designed to allow the user to select any combination of these activities, with the option of entering multiple instances of each (except for Natural Fire and Herbivory), based on timing, location within the landscape, and frequency of occurrence. Up to 100 separate activities may be entered. These may be 100 instances of

prescribed fire, for example, or a combination of 100 instances of all the available disturbances.



The default native herbivores are insects, rabbits, and deer. While multiple species occur within each category, and their respective diets and foraging behaviors differ, EDYS-L uses an “average” species that represents each category. Thus the “deer” category is an average between while-tailed deer and mule deer. As additional species are needed and identified, the list of native herbivores will be expanded.

For all activities except Natural Fire and Herbivory, three options exist for selecting the spatial extent of an activity. When an activity is checked on the right-hand panel, the following window is used to determine its spatial extent. Each option is detailed below.



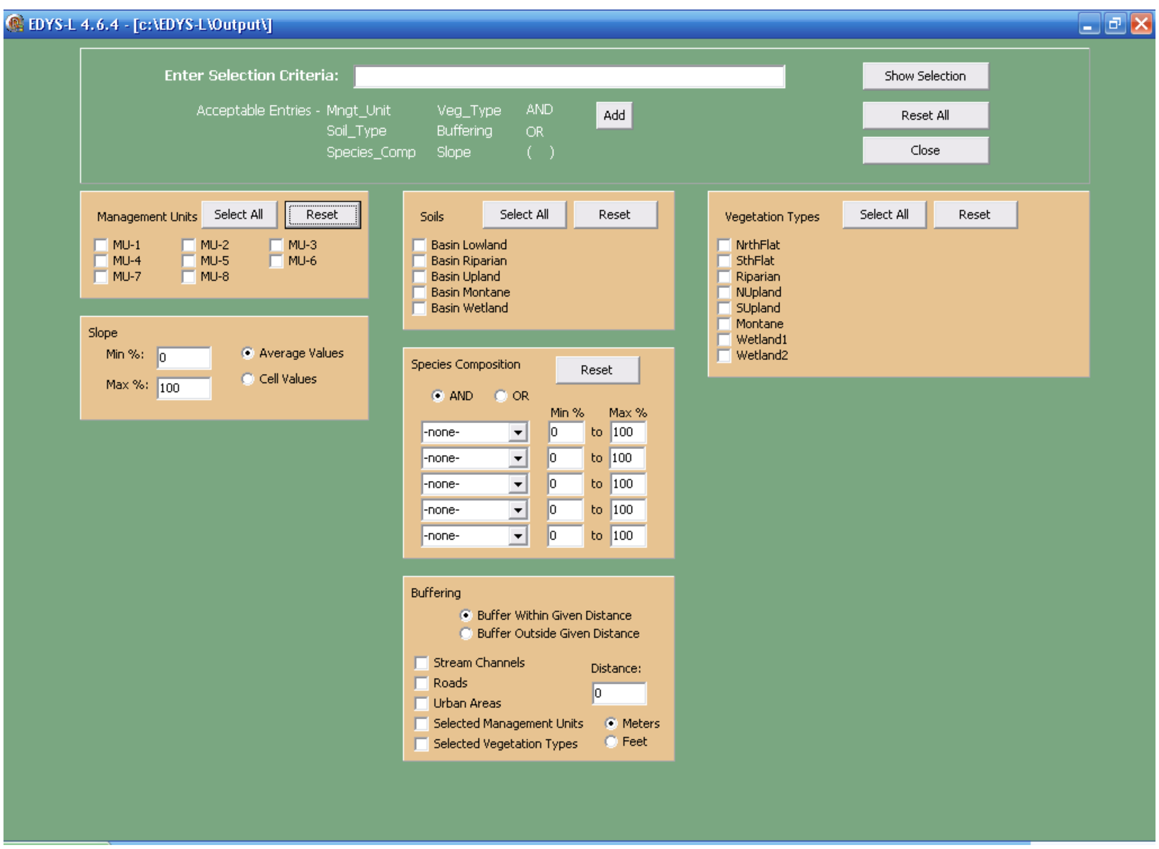
3.5.1 Selection via a map

After clicking on "Click on Map," the management unit grid will be displayed with units shown in different colors, and all other activity options will be disabled. If the user input GIS shapefiles to build the spatial configuration, the management unit grid will reflect the spatial data input in the managment unit shapefile. If the landscape was built from scratch (with no GIS inputs), the management unit grid will reflect the vegetation grid that was built.

To select the spatial location of the activity, click on the appropriate management unit. The user will be prompted with the management unit number and asked to verify that the correct unit was selected.

3.5.2 Selection using detailed criteria

When "Detailed Criteria" is selected, the following window will appear. It will allow the user to select the extent on a variety of landscape characteristics. These are detailed below.



3.5.2.1 Selection Criteria

The Selection Criteria box is used to build a Boolean logic string EDYS-L evaluates to derive the spatial extent of the activity. All acceptable entries are listed under the box. To build a string, follow these steps:

1. Highlight the desired entry. Clicking on the string will highlight it in blue.
2. Click on “Add.” The highlighted string will appear in the Selection Criteria box.
3. Use Boolean evaluators (AND and OR) as needed to build a logical Boolean string.
4. Repeat as needed.

Examples of appropriate Boolean logic strings are:

- Veg_Type AND Slope
- Species_Comp AND (Buffering OR Slope)
- Soil_Type OR Mngt_Unit

3.5.2.2 Management units

All management units available for selection will be listed. Select any combination of units, as desired. The “Select All” button will select all of them, while the “Reset” button will clear all selections.

3.5.2.3 Slope

Slope is calculated in EDYS-L as the elevational difference between a cell and its adjacent cells. Use of slope for detailed criteria involves setting a range of values, listed as Min % and Max %, and whether values averaged across a community or individual cell values will be used.

3.5.2.4 Soils

All soil types used in the landscape will be available for selection. Select any combination of soils, as desired. The “Select All” button will select all of them, while the “Reset” button will clear all selections.

3.5.2.5 Species composition

Species composition of the plant communities may be used as one criterion. Up to five plant species may be included. For each, the range of composition

values that are acceptable must be specified. Also, the user may specify the Boolean operator to use between more than one species. For example, the desired condition may be all communities that support cottonwood or mesquite. So the Boolean OR operator would be appropriate. If the desired condition was for communities that supported both cottonwood and mesquite, then use of the Boolean AND operator would be appropriate.

3.5.2.6 Buffering

The selected area may be based on the distance from certain features in the landscape, and the Buffering option allows this capability. The user may select from one or more of the following landscape features for buffering:

- Stream Channels
- Roads
- Urban Areas
- Selected Management Units
- Selected Vegetation Types

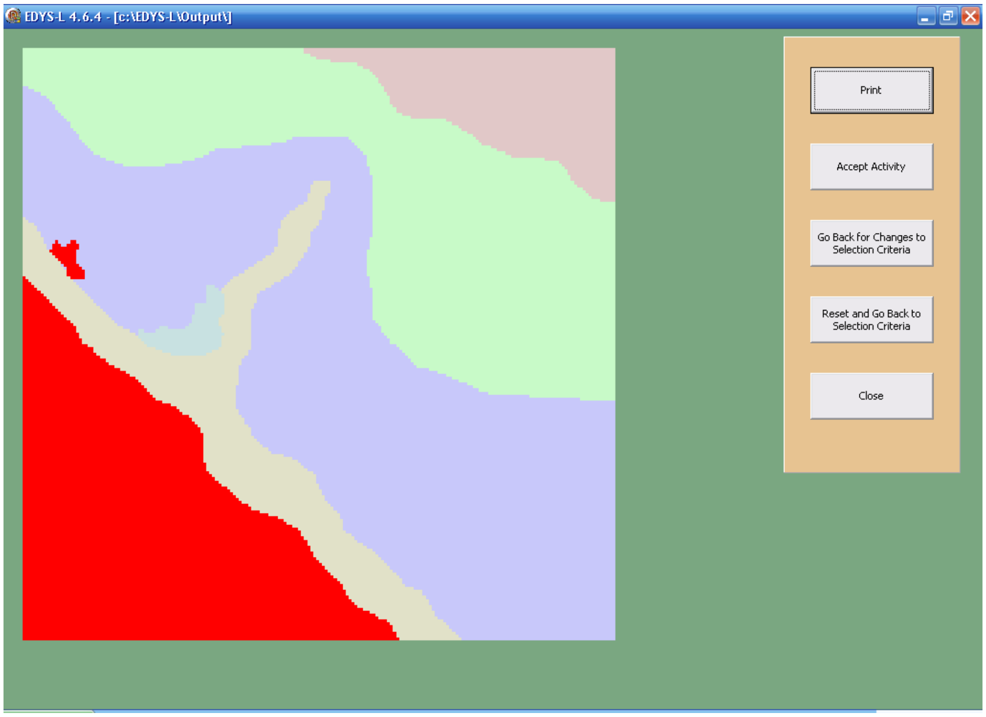
The user must select the width of the buffer zone and whether that width is measured in meters or feet. Additionally, the activity may be chosen to occur within the buffer zone, or outside of the buffer zone. An example of an appropriate activity occurring outside a buffer zone would be a prescribed fire that was not allowed to burn within a given distance of a stream channel. Conversely, a seeding operation may only be conducted within a buffer zone around a road to stabilize the road bank.

3.5.2.7 Vegetation types

All vegetation types used in the landscape will be available for selection. Select any combination of vegetation, as desired. The “Select All” button will select all of them, while the “Reset” button will clear all selections.

3.5.2.8 Saving the detailed criteria results

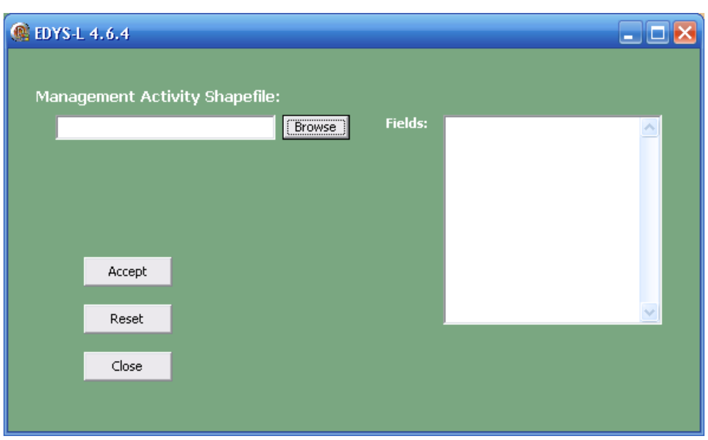
The next step is to show the results of the given detailed criteria. If it is correct, then it can be saved for use during the simulation run. If not, the criteria can be altered or corrected to achieve the desired spatial extent. Click on “Show Selection” to bring up a window like the example given below.



In this example, the spatial extent of the activity is shown in red. The "Print" button will generate a printout that includes not only the map as shown here, but also all the given criteria. "Accept Activity" saves the map and returns flow back to the Management Activities Window.

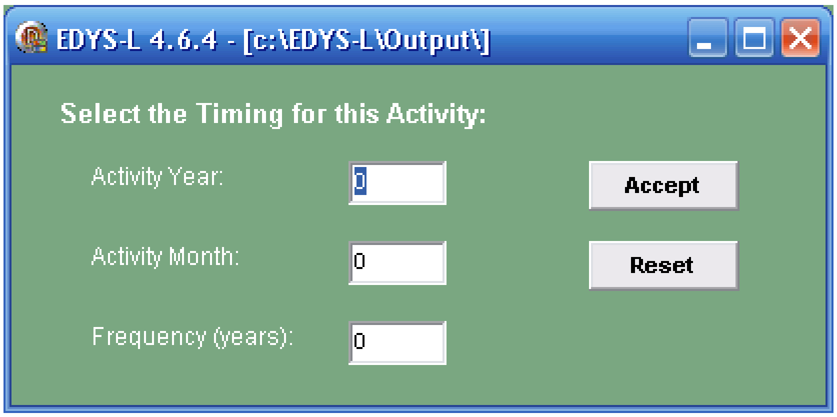
3.5.3 Input shapefile

A shapefile may be created using GIS to determine the spatial extent of an activity. The following window is used to input the desired shapefile. Functionally, this window works as described above for using shapefiles to designate the vegetation map for the application. See Section 3.2.1.1 for details.



3.5.4 Setting the timing of an activity

This window appears when any of several management activities have been selected. It allows the user to specify the time the event will occur and its frequency.



Activity Year corresponds to the year number during the EDYS-L run for the event to occur. Simulations begin on 1 January of Year One. If year is not explicitly stated, it defaults to year one. Activity Month corresponds to the month of the year when the event occurs. It should be input as the numerical month of the year, and ranges from 1 to 12. Activity Frequency is the frequency in years between events (i.e. an event that occurs in years one and four will have a frequency value of three). If zero, then the event is a one-time occurrence.

3.5.5 Management activity descriptions

Below are short descriptions for all management activities supported in EDYS-L. For all except Natural Fire and Herbivory, once an instance of the activity has been specified, the user will be prompted whether another instance of the same activity will be entered. In this manner, the same activity can be simulated to occur at various locations in the landscape, at different times, or at different intervals.

Natural fire Simulates a natural fire. No other inputs are required. Natural fire is modeled as a stochastic process, which may be initiated at any month during the run. Determination of whether a fire will begin, and its spread pattern, is based on a cell's fuel load, moisture content, and a stochastic factor.

Prescribed fire Simulates a prescribed burn within a specified management unit area. The user must select the extent of the burn along with its timing. The intensity of the fire is based on the fuel load and the moisture content of the vegetation and soil.

Brush management Simulates brush management within a specified management unit. The user must select not only the extent of the operation and its timing, but also the proportion of loss for each species. Acceptable input values range from 0 to 1.00. However, if an integer value between 1 and 100 is entered, EDYS-L will interpret it as the percentage of loss. Each species can be entered separately, allowing the user to simulate various brush management techniques, such as chaining or clearing with a bulldozer.

Timber harvest Simulate timber harvest within a specified management unit. The user must select not only the extent of the operation and its timing, but also the proportion of loss for each species. Acceptable input values range from 0 to 1.00. However, if an integer value between 1 and 100 is entered, EDYS-L will interpret it as the percentage of loss. Each species can be entered separately, allowing the user to simulate the potential impacts of harvest on secondary species due to the disturbance inherent in a timber harvest operation.

Fertilization Simulates the application of fertilizer within a specified area. The user must select the area of application, the timing of the application, and the amount of fertilizer (in lb/acre) to be applied.

Seeding Simulates a seeding operation within a specified area. The user will need to select the area to be seeded, the timing of the seeding and the amount of seed to apply. All species in the application are available for seeding. While some species would not purposefully be included in a seed mix, this allows the user to simulate other instances when seeds

may be applied to an area, such as the invasion of an exotic species.

Seedling planting Simulates planting of seedlings in a given area. The user must select the extent of the area to be planted, the timing of the planting, and the number of seedlings per acre for each species to be planted. All species in the application are available for this activity.

Chemical control Simulates application of an herbicide. The user will need to select the area to be sprayed, the timing of the spraying, and the impact of the herbicide on each species. The impact is given as the proportion of loss for each species. Acceptable values range from 0 to 1.00. However, if an integer value between 1 and 100 is entered, EDYS-L will interpret it as the percentage of loss. Each species can be entered separately, allowing the user to set differential rates of response.

Herbivory Grazing by native herbivores (insects, rabbits, and deer) is simulated as a uniform consumption rate across the entire landscape. The user has the choice of density of animals for each herbivore:

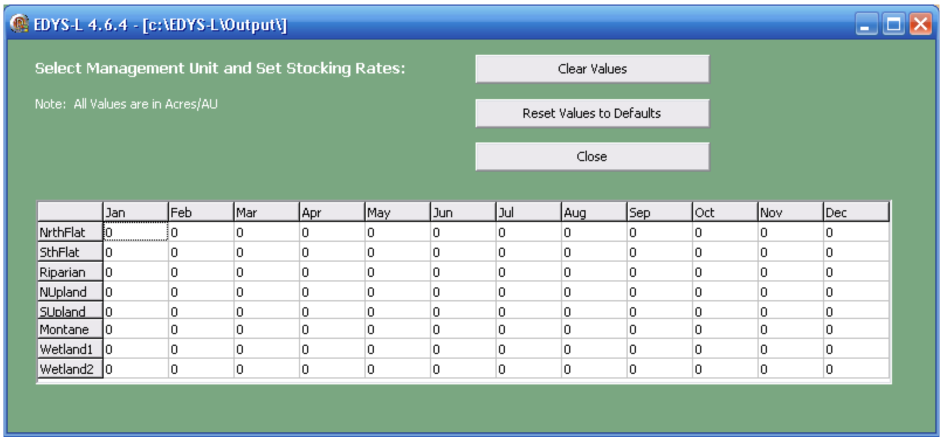
Insects
- Light – 3 individuals / m^2
- Moderate – 6 / m2
- Heavy – 12 / m2

Rabbits
- Light – 0.30 individuals / ha
- Moderate – 0.56 / ha
- Heavy – 0.78 / ha

Deer
- Light – 0.0824 / ha
- Moderate – 0.124 / ha
- Heavy – 0.247 / ha

Grazing by cattle is simulated as a constant rate within each vegetation type. When “Cattle” is

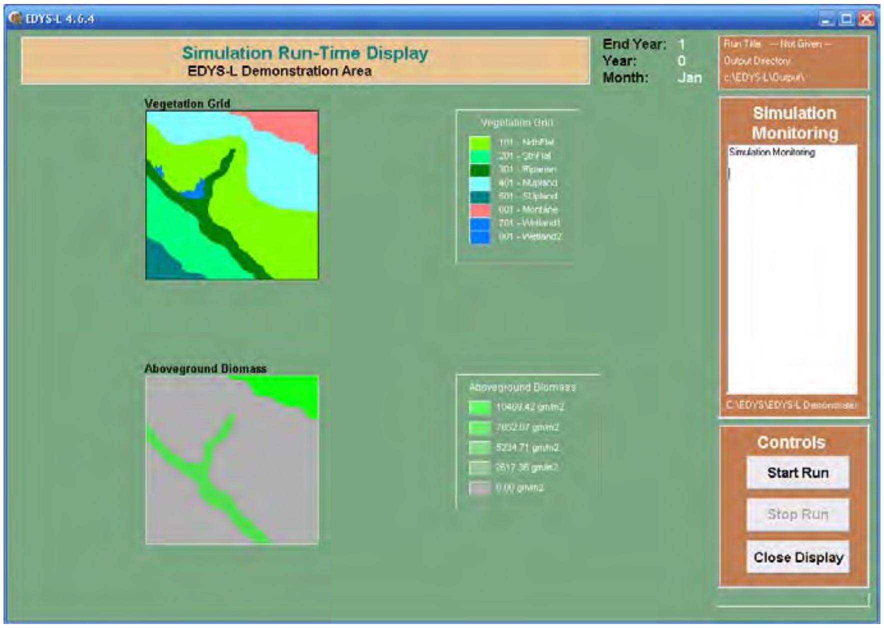
selected, the following window appears. The user can set the stocking rate, in acres/AU, for each vegetation type for each season of the year. This allows the simulation of different stocking regimes.



3.6 Run display

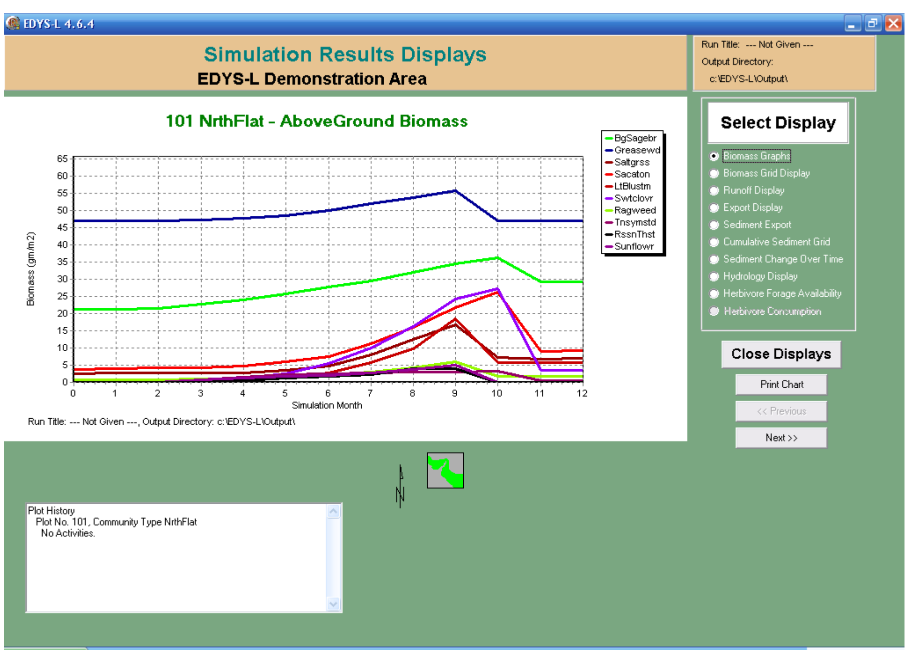
The Run Display Window, as shown below, serves three functions in EDYS-L. First, it shows the initial conditions prior to launching the simulation run. Second, it allows the user to monitor conditions during the run. It displays grids if any were selected by the user on the options window, displays the current month and year of the simulation, and updates the user on events such as precipitation and runoff. The progress bar below the "Close Display" button allows the user to monitor the progress of a run. Last, it allows the user to begin the simulation run or stop a run that has begun. Three buttons are available to control the run:

Start Run	To begin a simulation run.
Stop Run	To stop a simulation run. Execution will cease at the start of the next day of the run. This button only becomes enabled once the simulation has begun.
Close Display	Returns control to the Main Window after the simulation has completed or stopped with the Stop Run button.



3.7 Results display

The Results Display Window allows the user to display some of the results from an EDYS-L run. The panel on the right-hand side of the form, called "Select Display," allows the user to select which set of results to view. The choices are listed below the example of the window. An example of a biomass graph is shown in the screen capture below. To exit the Results Display Window, click on the Close Display button. This returns the user to the Main Window.



Biomass Graphs	Graphs of monthly aboveground biomass for each species. Separate graphs are generated for each plot type. When this option is selected, the graph is shown on the center portion of the form. In the bottom right-hand corner is a map of the simulation area with the graphed plot type highlighted in green. In the lower left-hand corner is a box detailing the management activity history for that plot type. Also, two buttons, labeled “Previous” and “Next,” appear on the right side of the form. These allow the user to step through all of the plot types in sequence, but also to backtrack if desired. The user also has the option to print the display using the “Print Chart” button.
Biomass Grid Display	Spatial display of relative total biomass. Plot types with the greatest total biomass are shown as the brightest green, while plot types with low biomass values are shown as the dullest green.
Runoff Display	Graph of monthly total water runoff from the simulation area.
Export Display	Graph of monthly total water export (water moving below the rooting zone).
Sediment Display	Graph of monthly total sediment moved off the simulation area.
Cumulative Sediment Grid	Spatial display of sediment movement within the simulation area. Cells with total sediment loss are shown in shades of red, cells with sediment gain are shown in shades of blue, whereas cells with no change are shown as gray.

Sediment Change Over Time	Bar graph of the number of cells showing sediment change, either loss or gain, calculated annually.
Hydrology Display	Bar graph of the annual totals for precipitation, export, runoff, evaporation, transpiration, and interception.
Herbivore Forage Availability	Bar graph of the total biomass available for each herbivore's top three plant preferences.
Herbivore Consumption	Bar graph of the total biomass consumed for each herbivore by plant species. This option is available only when herbivory was selected from the Management Activity Window.

3.8 Outputs

All output files are written to the 'C:\EDYS-L\Output\' directory unless otherwise specified from the Options Window. Output files can be animated using the CorpsGlobe Model Animation Creation Application or 'AnimateKMZ' software, documented in Appendix C. The software can be downloaded from the specified link in the documentation.

C:\EDYS-L\Output\

If this directory does not exist when EDYS-L is started, EDYS-L creates it. Any output files from a previous EDYS-L run which may exist in that directory will be deleted when EDYS-L is restarted or when EDYS-L is reset and re-run. Thus, if the user desires to save outputs from EDYS-L runs, then those files should be moved into other directories for storage or the output directory must be changed from the Options Window.

In addition to any output files specified by the user in the Options Window (listed in Section 3.4 under "Print Options"), several files are automatically generated whenever EDYS-L is run (listed alphabetically):

Community Cell Counts.txt

This file contains monthly cell counts for each plot type. It is "comma delimited" and ready to import into a spreadsheet for viewing, printing, or graphing.

Daily Sediment Movement.txt

This file records any changes in profile depth due to erosion and deposition. It is written to only after erosion events. It is "comma delimited" and ready to import into a spreadsheet for viewing, printing, or graphing.

EDYS Simulation Log.txt

This file serves as a simulation log file and contains a variety of information about the current EDYS-L run, including the date and time of the run, a listing of management activities, precipitation values, and summaries of plot dynamics whenever new plot types are created. This file's primary value is for diagnosing problems encountered during a simulation run.

List of Options and Activities.txt

This file contains a list of options and activities for the current EDYS-L run. It is ready for input into a word processor for viewing or printing.

Monthly Plot Slope Avg.txt

This file lists the monthly average slope for cells within each plot type or community. It is "comma delimited" and ready to import into a spreadsheet for viewing, printing, or graphing.

Monthly Runoff Totals.txt

This file contains monthly runoff totals for each plot type. It is "comma delimited" and ready to

import into a spreadsheet for viewing, printing, or graphing.

Options.txt

This file contains a list of all options input for the current EDYS-L run. Although in text format, this file is used internally by EDYS-L and the values will not be easily recognizable by the user.

Plant Component Biomass.csv

This file lists the biomass for each plant component in each community on a monthly basis. It is “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

Plant Parameter Inputs.txt

This file contains a listing of all plant parameter values. It is ready for input into a word processor for viewing or printing.

Shear Stress during Precip Events.txt

This file lists information regarding the potential for slope failure during precipitation events. It is “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

Summary of Community Extents.tst

This file lists the spatial extent, in hectares, of each community. If, after management activities, new communities are created, this file lists the reason for the creation of each new community. It is “comma delimited” and ready to import into a spreadsheet for viewing, printing, or graphing.

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Appendix A. Plant Communities

Table A1. Common and scientific names of default plant species.

Common Name	Scientific Name
Alkali sacaton	*Sporobolus airoides*
Baltic rush	*Juncus balticus*
Bermudagrass	*Cynodon dactylon*
Big sagebrush	*Artemisia tridentata*
Blue grama	*Bouteloua gracilis*
Cattail	*Typha latifolia*
Cottonwood	*Populus fremontii*
Coyote willow	*Salix exigua*
Creosotebush	*Larrea tridentata*
Little bluestem	*Schizachyrium scoparium*
Mesquite	*Prosopis glandulosa*
Ponderosa pine	*Pinus ponderosa*
Ragweed	*Ambrosia artemisiifolia*
Russian thistle	*Salsola kali*
Saltgrass	*Distichlis spicata*
Smooth cordgrass	*Spartina alterniflora*
Sunflower	*Helianthus sp.*
Sweetclover	*Melilotus sp.*
Tansymustard	*Descurainia pinnata*

Table A2. Plant growth forms and default species found in the Southwest Subregion of the Western Region.

Montane Community		
Growth Form	**Default Species**	**Initial Biomass (g/m2)**
Conifer	Ponderosa pine	30401.1
Deciduous tree	Mesquite	0.5
Shrub	Big sagebrush	6.2
Shrub	Creosotebush	57.0
Shortgrass	Blue grama	25.7
Mid-grass	Little bluestem	53.6
Mid-grass	Alkali sacaton	14.2
Meadow/marsh grass	Smooth cordgrass	5.8

Perennial warm-season forb	Ragweed	4.5
Perennial cool-season forb	Tansymustard	0.2
Upland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m2)**
Deciduous tree	Mesquite	20.7
Shrub	Creosotebush	35.9
Shortgrass	Blue grama	42.8
Meadow/marsh grass	Saltgrass	1.3
Mid-grass	Little bluestem	0.2
Mid-grass	Alkali sacaton	5.5
Perennial warm-season forb	Ragweed	2.8
Perennial cool-season forb	Tansymustard	0.2
Annual forb	Sunflower	0.2
Annual warm-season forb	Russian thistle	0.7
Lowland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m2)**
Deciduous tree	Mesquite	805.6
Mid-grass	Bermudagrass	35.1
Meadow/marsh grass	Saltgrass	25.4
Mid-grass	Alkali sacaton	335.7
Wetland	Baltic rush	23.1
Perennial cool-season forb	Tansymustard	2.6
Annual forb	Sunflower	2.9
Legume	Sweetclover	24.7
Annual warm-season forb	Russian thistle	3.7
Riparian Community		
Growth Form	**Default Species**	**Initial Biomass (g/m2)**
Deciduous tree	Cottonwood	19001.2
Shrub	Big sagebrush	8.3
Shrub	Coyote willow	1.8
Shortgrass	Blue grama	6.8
Meadow/marsh grass	Bermudagrass	6.5
Meadow/marsh grass	Saltgrass	17.7
Mid-grass	Little bluestem	2.4
Mid-grass	Alkali sacaton	7.6
Meadow/marsh grass	Smooth cordgrass	7.2
Wetland	Baltic rush	12.2
Perennial warm-season forb	Ragweed	16.2
Perennial cool-season forb	Tansymustard	2.5
Annual forb	Sunflower	10.9
Annual warm-season forb	Russian thistle	8.2

Wetland Community		
Growth Form	Default Species	Initial Biomass (g/m^2)
Shrub	Coyote willow	1.8
Shortgrass	Blue grama	0.1
Meadow/marsh grass	Saltgrass	3.2
Mid-grass	Little bluestem	0.1
Mid-grass	Alkali sacaton	9.7
Mid-grass	Smooth cordgrass	424.6
Wetland	Baltic rush	42.0
Wetland	Cattail	1032.7
Perennial warm-season forb	Ragweed	3.5
Perennial cool-season forb	Tansymustard	0.5
Annual forb	Sunflower	0.1
Legume	Sweetclover	0.1
Annual warm-season forb	Russian thistle	0.1

Table A3. Plant growth forms and default species found in the Central Plains Subregion of the Western Region.

Montane Community		
Growth Form	Default Species	Initial Biomass (g/m^2)
Conifer	Ponderosa pine	11624.0
Shrub	Big sagebrush	243.0
Shrub	Coyote willow	1.0
Shortgrass	Blue grama	51.5
Meadow/marsh grass	Saltgrass	1.4
Mid-grass	Little bluestem	3.4
Mid-grass	Alkali sacaton	2.7
Meadow/marsh grass	Smooth cordgrass	3.7
Perennial warm-season forb	Ragweed	11.5
Perennial cool-season forb	Tansymustard	3.7
Annual forb	Sunflower	4.1
Legume	Sweeclover	1.6
Annual warm-season forb	Russian thistle	1.1
Upland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Shrub	Big sagebrush	79.6
Shortgrass	Blue grama	35.7
Meadow/marsh grass	Saltgrass	0.9
Mid-grass	Alkali sacaton	6.9

Perennial warm-season forb	Ragweed	0.7
Perennial cool-season forb	Tansymustard	1.6
Annual forb	Sunflower	0.1
Legume	Sweetclover	2.9
Annual warm-season forb	Russian thistle	5.0
Lowland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Shortgrass	Blue grama	4.3
Mid-grass	Bermudagrass	44.5
Meadow/marsh grass	Saltgrass	0.2
Mid-grass	Little bluestem	170.0
Mid-grass	Alkali sacaton	53.4
Perennial warm-season forb	Ragweed	22.7
Perennial cool-season forb	Tansymustard	3.2
Annual forb	Sunflower	14.5
Legume	Sweetclover	4.7
Annual warm-season forb	Russian thistle	2.8
Riparian Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Deciduous tree	Cottonwood	31488.0
Shrub	Big sagebrush	2.6
Shrub	Coyote willow	1.3
Shortgrass	Blue grama	13.5
Meadow/marsh grass	Saltgrass	2.7
Mid-grass	Little bluestem	4.8
Meadow/marsh grass	Smooth cordgrass	14.4
Wetland	Baltic rush	21.2
Perennial warm-season forb	Ragweed	26.6
Perennial cool-season forb	Tansymustard	5.0
Wetland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Meadow/marsh grass	Smooth cordgrass	543.0
Wetland	Cattail	2065.0

Table A4. Plant growth forms and default species found in the Great Basin Subregion of the Western Region.

Montane Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Conifer	Ponderosa pine	10461.5
Shrub	Big sagebrush	0.7
Shrub	Coyote willow	1.1
Shortgrass	Blue grama	1.9
Mid-grass	Little bluestem	0.2
Mid-grass	Alkali sacaton	2.2
Perennial warm-season forb	Ragweed	1.9
Perennial cool-season forb	Tansymustard	0.2
Upland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Conifer	Ponderosa pine	0.7
Shrub	Big sagebrush	55.0
Shrub	Greasewood	1.5
Shrub	Coyote willow	0.1
Shortgrass	Blue grama	5.2
Meadow/marsh grass	Saltgrass	1.2
Mid-grass	Little bluestem	8.4
Mid-grass	Alkali sacaton	13.1
Perennial warm-season forb	Ragweed	2.7
Perennial cool-season forb	Tansymustard	2.9
Annual forb	Sunflower	0.8
Legume	Sweetclover	0.6
Annual warm-season forb	Russian thistle	0.3
Lowland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Shrub	Big sagebrush	19.5
Shrub	Greasewood	52.7
Meadow/marsh grass	Saltgrass	14.8
Mid-grass	Little bluestem	2.4
Mid-grass	Alkali sacaton	4.0
Perennial warm-season forb	Ragweed	11.3
Perennial cool-season forb	Tansymustard	0.1
Annual forb	Sunflower	0.2
Legume	Sweetclover	0.6
Annual warm-season forb	Russian thistle	1.0

Riparian Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Deciduous tree	Cottonwood	6514.4
Shrub	Big sagebrush	13.9
Shrub	Coyote willow	2.2
Mid-grass	Bermudagrass	13.0
Meadow/marsh grass	Saltgrass	52.7
Mid-grass	Alkali sacaton	15.1
Wetland	Baltic rush	3.1
Perennial warm-season forb	Ragweed	5.7
Annual forb	Sunflower	21.7
Annual warm-season forb	Russian thistle	16.3
Wetland Community		
Growth Form	**Default Species**	**Initial Biomass (g/m^2)**
Shrub	Coyote willow	3.6
Shortgrass	Blue grama	0.2
Meadow/marsh grass	Saltgrass	6.4
Mid-grass	Little bluestem	0.2
Mid-grass	Alkali sacaton	19.3
Meadow/marsh grass	Smooth cordgrass	306.1
Wetland	Baltic rush	84.0
Wetland	Cattail	0.3
Perennial warm-season forb	Ragweed	7.0
Perennial cool-season forb	Tansymustard	1.0
Annual forb	Sunflower	0.2
Legume	Sweetclover	0.1
Annual warm-season forb	Russian thistle	0.2

Appendix B. Soils

Table B1. Pedons used to derive default soil types for each subregion and community.

SubRegion	EDYS-L Community	Pedon No.	Location	Vegetative Association
Southwest	Montane	36	Dona Ana Co. NM	creosotebush
Southwest	Upland	40	Dona Ana Co. NM	creosotebush
		57	Pinal Co. AZ	creosotebush
		63	Lincoln Co. NV	creosotebush-shadscale
		128	Riverside Co. CA	goldenbush-bromes
		97	Monterey Co. CA	annual bromes
		12	San Diego Co. CA	wild oats/weeds
		79	San Diego Co. CA	weeds
		129	San Diego Co. CA	weeds
Southwest	Lowland	31	Dona Ana Co. NM	black grama-mesquite
		58	Cochise Co. AZ	sacaton-tobosa
		59	Cochise Co. AZ	blue grama-black grama
		62	Dona Ana Co. NM	black grama-threeawn
		56	Cochise Co. AZ	blue grama
		60	Dona Ana Co. NM	mesquite-snakeweed
		69	Dona Ana Co. NM	mesquite
		61	Clark Co. NV	creosotebush-bursage
		64	Clark Co. NV	creosotebush-bursage
		39	Reeves Co. TX	saltbush-tarbush
Southwest	Riparian	65	Clark Co. NV	mesquite (6 m)-quailbush
		67	El Paso Co. TX	cultivated floodplain
Southwest	Wetland	123	Dona Ana Co. NM	weeds (playa)
Plains	Montane	48	Grand Co. CO	lodgepole pine
Plains	Upland	18	Williams Co. ND	western wheatgrass
		23	Blaine Co. MT	western wheatgrass
		87	Bowman Co. ND	blue grama-needle-and-thread
		93	Carson Co. TX	blue grama-buffalograss
		85	Judith Basin Co. MT	fescue-brome
		94	Zavala Co. TX	bristlegrass
		95	Butler Co. KS	native meadow

SubRegion	EDYS-L Community	Pedon No.	Location	Vegetative Association
		91	Ottawa Co. OK	cultivated grains
		70	Ford Co. KS	sand bluestem (sand hills)
		52	Lynn Co. TX	cultivated
Plains	Lowland	4	Chase Co. KS	little bluestem
		92	Webster Co. NE	big bluestem-sideoats
		86	Stark Co. ND	crested wheatgrass
		1	Ford Co. KS	fallow field
		5	Dickey Co. ND	grain field
		127	Collin Co. TX	cotton field
Plains	Riparian			
Plains	Wetland	43	Colleton Co. SC	tidal marsh
Great Basin	Montane	115	Nevada Co. CA	ponderosa pine-cedar
		122	Amador Co. CA	ponderosa pine-black oak
		53	Placer Co. CA	brome-clover
		111	Ferry Co. WA	Douglas fir-pine
Great Basin	Upland	37	Sanpete Co. UT	big sagebrush-bluebunch
		130	Salt Lake Co. UT	big sagebrush-bluebunch
		98	Elko Co. NV	big sagebrush-rabbitbrush
Great Basin	Lowland	100	Douglas Co. NV	greasewood-big sagebrush
		41	San Bernardino Co. CA	shadscale
		54	Solano Co. CA	saltgrass
		55	Solano Co. CA	cultivated
Great Basin	Riparian	76	Klamath Co. OR	clover-bluegrass
Great Basin	Wetland	6	Tillamook Co. OR	grasses and ferns
		101	Wallowa Co. OR	bluegrass-sedges

Table B2. Southwest Montane soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	5.6	15.2	48.1	506.7	14.3
50	5.6	15.2	48.1	1013.3	28.6
50	5.6	15.2	48.1	1013.3	28.6
55	5.6	15.2	48.1	1114.7	31.4
60	10.4	17.9	33.0	658.5	26.6
60	10.4	17.9	33.0	658.5	26.6
75	14.8	21.8	40.6	538.3	21.1
85	14.8	21.8	40.6	610.0	23.9
100	14.8	21.8	40.6	717.7	28.1
75	14.9	21.9	40.9	412.2	23.6
75	14.9	21.9	40.9	412.2	23.6
100	14.9	21.9	40.9	549.6	31.4
80	13.7	19.8	31.5	564.5	21.7
80	13.7	19.8	31.5	564.5	21.7
75	12.8	18.6	30.2	416.4	20.8
75	12.8	18.6	30.2	416.4	20.8
80	12.8	18.6	30.2	444.2	22.2
100	0.0	1.0	1.0	0.0	15.0
150	0.0	1.0	1.0	0.0	22.5
200	0.0	1.0	1.0	0.0	30.0

Table B3. Southwest Upland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
30	6.3	14.7	42.3	784.0	43.0
40	5.6	16.3	39.5	294.2	24.3
50	5.6	16.3	39.5	367.8	30.4
50	6.9	12.1	36.5	2441.8	9.5
60	6.9	12.1	36.5	2930.2	11.4
100	10.2	20.4	37.5	930.9	59.4
130	10.2	20.4	37.5	1210.1	77.2
90	11.7	22.5	40.9	814.5	50.5
110	11.7	22.5	40.9	995.5	61.8
80	14.4	24.6	38.8	1133.3	70.8
100	14.4	24.6	38.8	1416.7	88.6
120	13.5	24.0	41.2	1599.7	100.4
140	13.5	24.0	41.2	1866.3	117.2
200	13.7	22.9	37.3	896.0	56.4
300	10.0	21.6	33.5	950.0	58.1
200	10.5	22.3	40.7	345.0	22.0
200	8.3	24.1	43.8	328.0	20.9
300	8.3	24.1	43.8	492.0	31.3
300	6.1	25.9	46.8	84.0	4.2
400	6.1	25.9	46.8	112.0	5.6

Table B4. Southwest Lowland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	2.7	8.3	36.4	260.5	13.5
25	2.7	8.3	36.4	260.5	13.5
100	3.8	8.4	37.2	847.0	49.8
80	4.4	9.6	36.8	615.0	41.4
70	5.5	11.7	35.3	551.0	37.1
130	15.4	25.7	34.6	787.0	49.5
150	15.7	27.4	34.9	1290.0	82.6
80	17.4	32.9	37.8	840.0	52.5
180	14.0	23.1	41.0	842.0	53.4
130	11.4	18.1	41.0	507.0	30.4
200	8.2	18.2	40.4	221.4	12.7
230	8.2	18.2	40.4	254.6	14.5
300	7.7	18.5	38.9	97.4	4.8
350	7.7	18.5	38.9	113.6	5.7
300	6.2	11.2	35.1	103.0	5.2
350	6.7	17.6	35.9	119.0	6.0
375	3.5	8.1	36.6	126.2	6.3
475	3.5	8.1	36.6	159.8	8.0
300	3.4	6.7	37.4	99.0	5.1
400	3.4	6.7	37.4	132.0	6.8

Table B5. Southwest Riparian soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	20.4	31.0	33.5	533.9	28.0
30	20.4	31.0	33.5	640.6	33.6
55	20.4	31.0	33.5	1174.5	61.6
40	22.1	32.0	34.4	464.0	27.0
50	15.4	27.8	34.7	912.0	54.2
70	14.6	24.4	35.6	928.4	54.7
90	14.6	24.4	35.6	1193.6	70.4
80	13.6	23.4	47.0	537.6	33.6
120	13.6	23.4	47.0	806.4	50.4
100	14.0	30.5	45.8	658.0	47.2
100	14.0	30.5	45.8	658.0	47.2
130	10.7	28.0	52.0	528.5	31.4
160	10.7	28.0	52.0	650.5	38.6
125	18.2	28.1	32.7	823.3	62.3
150	18.2	28.1	32.7	988.0	74.8
175	18.2	28.1	32.7	1152.7	87.2
150	16.0	26.7	38.7	1045.5	72.9
200	16.0	26.7	38.7	1394.0	97.2
200	16.0	26.7	38.7	1394.0	97.2
300	16.0	26.7	38.7	2091.0	145.8

Table B6. Southwest Wetland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	19.1	31.8	41.9	394.0	24.5
25	19.1	31.8	41.9	394.0	24.5
40	18.8	32.8	43.1	480.0	30.0
60	18.8	32.8	43.1	720.0	45.0
80	18.8	32.8	43.1	960.0	60.0
75	19.4	30.8	40.8	538.2	33.9
75	19.4	30.8	40.8	538.2	33.9
100	19.4	30.8	40.8	717.6	45.2
75	19.5	29.5	36.8	538.6	40.1
75	19.5	29.5	36.8	538.6	40.1
80	19.5	29.5	36.8	574.5	42.8
100	19.5	29.5	36.8	718.2	53.5
80	20.0	29.0	36.0	693.6	47.6
80	20.0	29.0	36.0	693.6	47.6
80	20.0	29.0	36.0	693.6	47.6
100	20.0	29.0	36.0	867.1	59.5
100	20.0	29.0	35.7	969.0	59.5
125	20.0	29.0	35.7	1211.3	74.4
125	20.0	29.0	35.7	1211.3	74.4
150	20.0	29.0	35.7	1453.5	89.3

Table B7. Central Plains Montane soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	5.6	15.2	48.1	506.7	14.3
50	5.6	15.2	48.1	1013.3	28.6
50	5.6	15.2	48.1	1013.3	28.6
55	5.6	15.2	48.1	1114.7	31.4
60	10.4	17.9	33.0	658.5	26.6
60	10.4	17.9	33.0	658.5	26.6
75	14.8	21.8	40.6	538.3	21.1
85	14.8	21.8	40.6	610.0	23.9
100	14.8	21.8	40.6	717.7	28.1
75	14.9	21.9	40.9	412.2	23.6
75	14.9	21.9	40.9	412.2	23.6
100	14.9	21.9	40.9	549.6	31.4
80	13.7	19.8	31.5	564.5	21.7
80	13.7	19.8	31.5	564.5	21.7
75	12.8	18.6	30.2	416.4	20.8
75	12.8	18.6	30.2	416.4	20.8
80	12.8	18.6	30.2	444.2	22.2
100	0.0	1.0	1.0	0.0	15.0
150	0.0	1.0	1.0	0.0	22.5
200	0.0	1.0	1.0	0.0	30.0

Table B8. Central Plains Upland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	6.8	16.4	46.7	1696.6	58.8
55	6.8	16.4	46.7	3732.4	129.4
50	13.6	21.8	36.7	1428.0	78.9
50	14.8	21.8	40.4	1271.0	77.2
50	10.8	19.4	40.7	749.0	51.2
80	8.4	16.7	40.9	686.4	43.7
120	8.4	16.7	40.9	1029.6	65.5
80	10.9	18.4	33.0	778.9	49.6
100	10.9	18.4	33.0	973.6	62.0
100	10.9	18.4	33.0	973.6	62.0
130	11.5	21.4	32.6	1272.7	81.0
160	11.5	21.4	32.6	1566.3	99.7
150	11.7	21.6	33.4	1452.0	92.4
150	11.7	21.6	33.4	1452.0	92.4
100	12.1	21.9	35.6	1139.2	76.5
150	12.1	21.9	35.6	1708.8	114.8
200	15.1	25.9	36.8	2071.0	137.0
200	15.1	25.9	36.8	2071.0	137.0
250	15.1	18.0	35.8	1360.0	93.5
300	15.1	18.0	35.8	1632.0	112.2

Table B9. Central Plains Lowland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	11.0	25.4	48.8	1473.8	66.2
50	11.0	25.4	48.8	2947.7	132.3
55	11.0	25.4	48.8	3242.5	145.5
50	14.0	30.5	44.7	2280.8	113.7
70	14.0	30.5	44.7	3193.2	159.1
80	15.4	27.8	34.2	3027.0	166.9
80	15.4	27.8	34.2	3027.0	166.9
80	18.2	28.1	32.3	1894.1	115.3
90	18.2	28.1	32.3	2130.9	129.8
100	16.0	26.7	38.7	1085.2	75.9
110	16.0	26.7	38.7	1193.8	83.4
100	11.3	28.1	47.3	570.0	32.0
110	11.3	28.1	47.3	627.0	35.1
100	11.8	29.8	47.8	441.7	24.8
100	11.8	29.8	47.8	441.7	24.8
100	11.8	29.8	47.8	441.7	24.8
200	11.3	29.0	47.4	778.0	44.5
150	10.8	28.2	47.1	525.0	29.4
200	10.8	28.2	47.1	700.0	39.2
300	10.8	28.2	47.1	1050.0	58.8

Table B10. Central Plains Riparian soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	20.4	31.0	33.5	533.9	28.0
30	20.4	31.0	33.5	640.6	33.6
55	20.4	31.0	33.5	1174.5	61.6
40	22.1	32.0	34.4	464.0	27.0
50	15.4	27.8	34.7	912.0	54.2
70	14.6	24.4	35.6	928.4	54.7
90	14.6	24.4	35.6	1193.6	70.4
80	13.6	23.4	47.0	537.6	33.6
120	13.6	23.4	47.0	806.4	50.4
100	14.0	30.5	45.8	658.0	47.2
100	14.0	30.5	45.8	658.0	47.2
130	10.7	28.0	52.0	528.5	31.4
160	10.7	28.0	52.0	650.5	38.6
125	18.2	28.1	32.7	823.3	62.3
150	18.2	28.1	32.7	988.0	74.8
175	18.2	28.1	32.7	1152.7	87.2
150	16.0	26.7	38.7	1045.5	72.9
200	16.0	26.7	38.7	1394.0	97.2
200	16.0	26.7	38.7	1394.0	97.2
300	16.0	26.7	38.7	2091.0	145.8

Table B11. Central Plains Wetland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	35.4	58.9	74.7	6554.5	227.5
75	35.4	58.9	74.7	19663.5	682.6
100	35.2	63.0	77.1	23003.0	815.8
100	35.2	63.0	77.1	23003.0	815.8
130	28.1	68.0	74.0	22445.9	705.8
150	28.1	68.0	74.0	25899.1	814.3
120	24.4	50.6	56.6	14271.9	491.0
160	24.4	50.6	56.6	19029.1	654.6
140	23.8	45.3	55.1	4482.4	313.5
150	23.8	45.3	55.1	4802.6	335.8
200	24.0	46.1	55.8	7114.0	476.5
200	24.3	49.2	56.1	8848.0	548.8
125	23.9	56.0	57.5	5683.5	322.7
125	23.9	56.0	57.5	5683.5	322.7
125	22.6	64.0	64.0	4067.5	247.4
125	22.6	64.0	64.0	4067.5	247.4
200	17.7	23.4	35.4	7538.0	354.9
200	17.7	23.4	35.4	7538.0	354.9
250	17.7	23.4	35.8	5407.5	270.5
300	17.7	23.4	35.8	6489.0	324.6

Table B12. Great Basin Montane soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	23.9	37.9	48.9	2871.3	63.1
75	23.9	37.9	48.9	8613.8	189.2
80	23.9	37.9	48.9	9188.0	201.8
80	24.1	40.2	58.1	3269.8	88.2
100	24.1	40.2	58.1	4087.2	110.2
100	25.5	40.6	56.0	2804.0	106.0
100	26.7	42.1	54.1	1787.9	67.2
120	26.7	42.1	54.1	2145.5	80.7
160	26.7	42.1	54.1	2860.6	107.5
100	28.7	49.1	56.0	1725.0	64.4
120	28.7	49.1	56.0	2070.0	77.3
140	28.7	49.1	56.0	2415.0	90.1
100	27.7	42.4	52.5	925.1	35.0
120	27.7	42.4	52.5	1110.2	42.0
130	27.7	42.4	52.5	1202.7	45.5
150	27.4	54.2	60.1	1039.5	39.4
150	27.4	54.2	60.1	1039.5	39.4
150	0.0	1.0	1.0	0.0	3.8
200	0.0	1.0	1.0	0.0	5.0
250	0.0	1.0	1.0	0.0	6.3

Table B13. Great Basin Upland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	16.4	43.2	63.4	1469.3	65.5
75	16.4	43.2	63.4	4407.8	196.4
80	15.9	42.7	60.6	4798.0	219.5
100	18.3	51.3	63.7	5274.0	248.4
100	18.3	51.3	63.7	5274.0	248.4
75	19.0	52.0	61.9	2662.5	128.8
75	19.0	52.0	61.9	2662.5	128.8
100	16.5	34.4	61.8	1940.5	88.1
110	16.5	34.4	61.8	2134.5	96.9
100	12.1	41.1	62.7	1804.2	92.6
120	12.1	41.1	62.7	2165.0	111.1
140	12.1	41.1	62.7	2525.8	129.6
100	12.0	41.0	62.0	1386.0	63.4
120	12.0	41.0	62.0	1663.2	76.0
130	12.0	41.0	62.0	1801.8	82.4
125	12.8	31.3	60.8	1120.0	51.5
125	12.8	31.3	60.8	1120.0	51.5
150	10.7	21.7	58.4	561.0	26.4
200	10.7	21.7	58.4	748.0	35.2
300	10.7	21.7	58.4	1122.0	52.8

Table B14. Great Basin Lowland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	4.8	14.3	36.6	415.0	43.6
50	4.8	14.3	36.6	830.0	87.2
75	4.8	14.3	36.6	1245.0	130.8
100	10.4	14.4	31.8	1313.8	97.2
110	10.4	14.4	31.8	1445.2	106.9
150	11.7	18.0	32.4	725.0	69.8
150	11.7	18.0	32.4	725.0	69.8
150	16.4	26.0	36.5	503.8	30.2
190	16.4	26.0	36.5	638.2	38.3
250	18.5	25.6	35.4	770.0	47.0
200	13.9	18.2	32.1	396.0	25.2
200	13.9	18.2	32.1	396.0	25.2
150	13.8	19.9	31.7	244.5	16.3
150	13.8	19.9	31.7	244.5	16.3
150	12.7	18.5	30.2	83.1	5.6
200	12.7	18.5	30.2	110.9	7.4
200	11.1	17.1	29.4	112.0	7.5
200	11.1	17.1	29.4	112.0	7.5
250	9.5	15.7	28.7	142.5	9.5
300	9.5	15.7	28.7	171.0	11.4

Table B15. Great Basin Riparian soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
20	27.0	90.9	90.9	2075.0	79.1
20	27.0	90.9	90.9	2075.0	79.1
40	13.0	39.7	54.9	2189.8	99.0
50	13.0	39.7	54.9	2737.2	123.8
50	8.8	34.5	52.6	967.0	44.7
50	8.8	34.5	52.6	967.0	44.7
75	6.6	23.5	48.9	607.5	24.3
75	6.6	23.5	48.9	607.5	24.3
80	3.3	22.7	49.3	300.3	12.9
80	3.3	22.7	49.3	300.3	12.9
100	3.3	22.7	49.3	375.4	16.1
80	1.0	7.6	39.6	153.5	6.4
80	1.0	7.6	39.6	153.5	6.4
100	1.0	7.6	39.6	191.9	8.0
100	0.0	1.0	1.0	0.0	5.0
150	0.0	1.0	1.0	0.0	7.5
200	0.0	1.0	1.0	0.0	10.0
200	0.0	1.0	1.0	0.0	10.0
200	0.0	1.0	1.0	0.0	10.0
300	0.0	1.0	1.0	0.0	15.0

Table B16. Great Basin Wetland soil characteristics.

Depth (mm)	Wilting Point (%)	Field Capacity (%)	Saturation (%)	Organic Matter (g/m2)	Total N (g/m^2)
25	35.4	58.9	74.7	6554.5	227.5
75	35.4	58.9	74.7	19663.5	682.6
100	35.2	63.0	77.1	23003.0	815.8
100	35.2	63.0	77.1	23003.0	815.8
120	28.1	68.0	74.0	20719.3	651.5
120	28.1	68.0	74.0	20719.3	651.5
140	28.1	68.0	74.0	24172.5	760.1
130	24.4	50.6	56.6	15461.2	531.9
150	24.4	50.6	56.6	17839.8	613.7
140	23.8	45.3	55.1	4482.4	313.6
150	23.8	45.3	55.1	4802.6	335.9
200	24.0	46.1	55.8	7114.0	476.5
200	24.3	49.2	56.1	8848.0	548.8
250	23.9	56.0	57.5	11367.0	645.3
250	22.6	64.0	64.0	8135.0	494.7
200	17.7	23.4	35.4	7538.0	354.9
200	17.7	23.4	35.4	7538.0	354.9
250	17.7	23.4	35.8	5407.5	270.5
250	17.7	23.4	35.8	5407.5	270.5
300	17.7	23.4	35.8	6489.0	324.6

Appendix C. AnimateKMZ Documentation

CorpsGlobe Model Animation Creation Application Documentation

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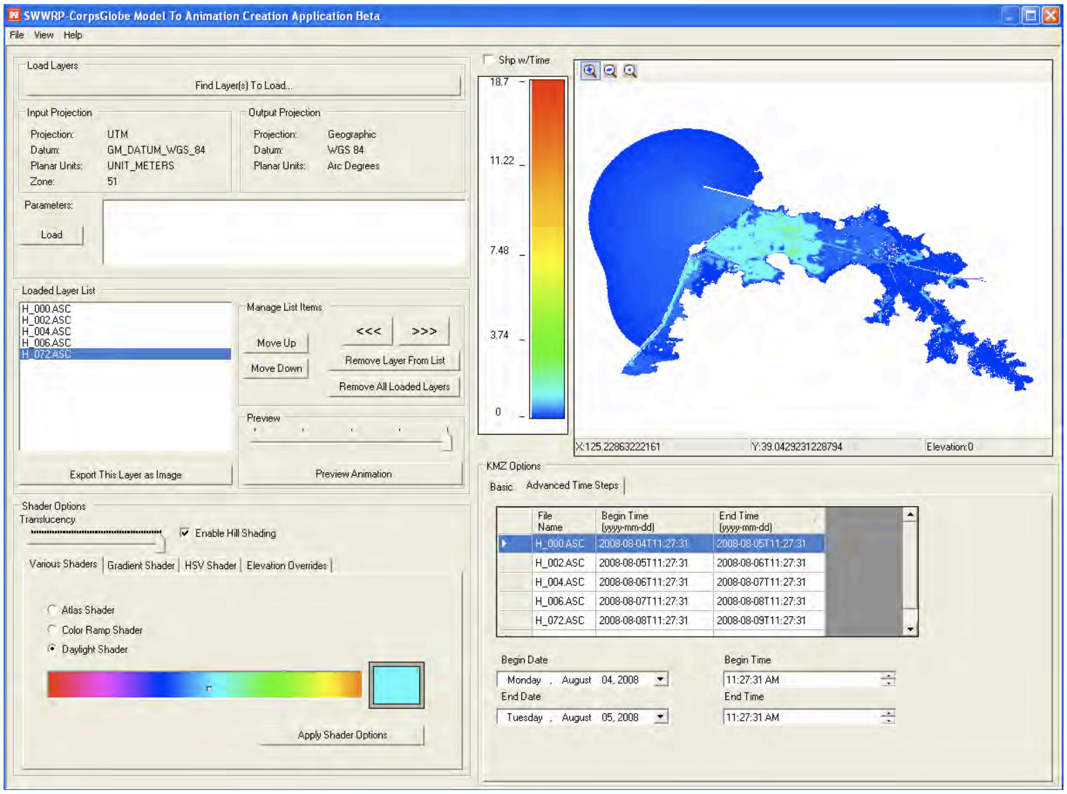
Output from EDYS can be animated in the Google Earth environment using a tool called “AnimateKMZ.” This tool, another product of the Corps of Engineers’ System-Wide Water Resources Program (SWWRP), is available for download at: https://corpsglobeweb.usace.army.mil/corpsglobe/.

When numeric models have finished generating solutions to problems, the user needs a mechanism for visualizing the results in a meaningful manner. The Corps Globe Animation creation application provides an easy-to-use mechanism for displaying temporally driven model outputs in a 2D/3D environment. This desktop application can ingest a number of model output formats or temporally related datasets, colorfully visualize their displays in many different manners (depending upon user preferences), and output a georeferenced KMZ file containing an animation file. This file can then be “played” inside of Google’s Google Earth application. Overlaying these animations in Google Earth is useful for conveying model results in a georeferenced context that is time related. This gives decision makers the ability to see the impacts of various scenarios in a visually meaningful manner while at the same time giving modelers the ability to verify, or validate, their model setup and results.



When the CorpsGlobe Model Animation Creation Application (AnimateKMZ) is launched, users are presented with the main dialog and no layers are loaded.

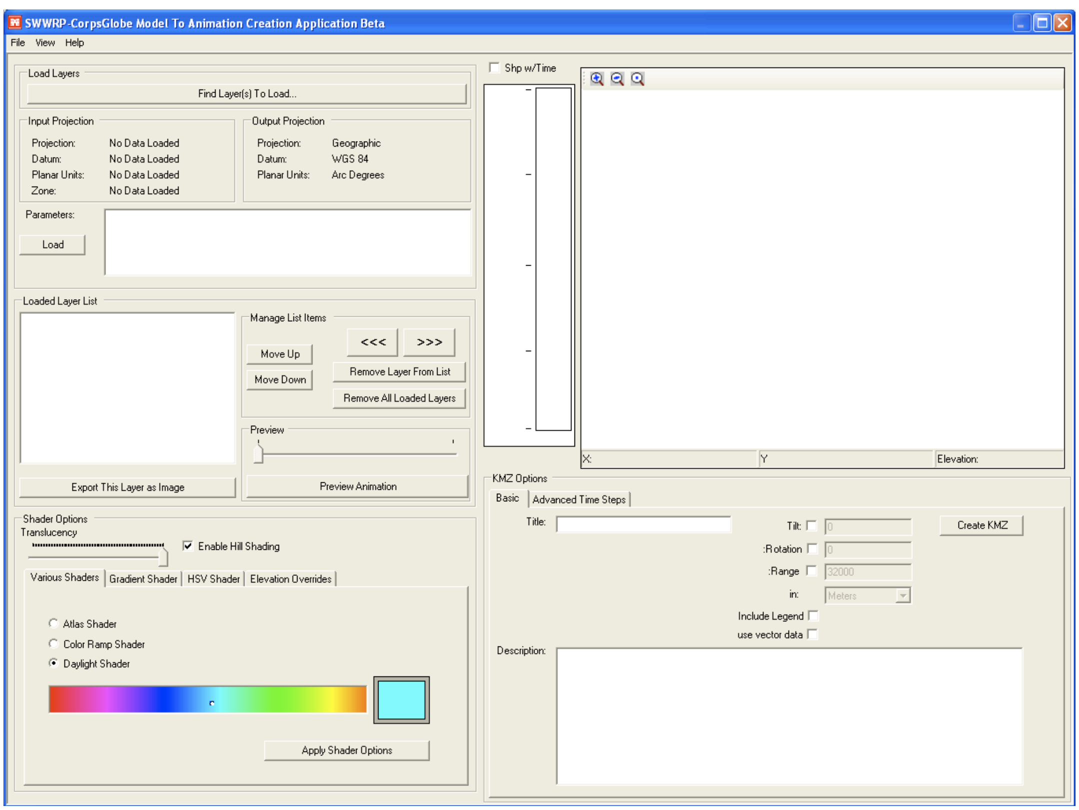


Figure C1. Main screen with no loaded layers.

The first thing users need to do is click the button labeled “Find Layers to Load.”

This brings up a typical dialog that allows users to browse their computer for files they would like to open. Users must be sure to choose the correct file type from the drop-down menu at the bottom of the open file dialog.

The output from EDYS is a GRIDASCII output for each day of the modeled scenario. GRIDASCII is a file transfer format supported by the ArcGIS software. Information regarding this format can be found at: (http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=ESRI%20ASCII%20Raster%20format). In AnimateKMZ, the GRIDASCII files are referred to as “Arc/Info ASCII Grid Files.”

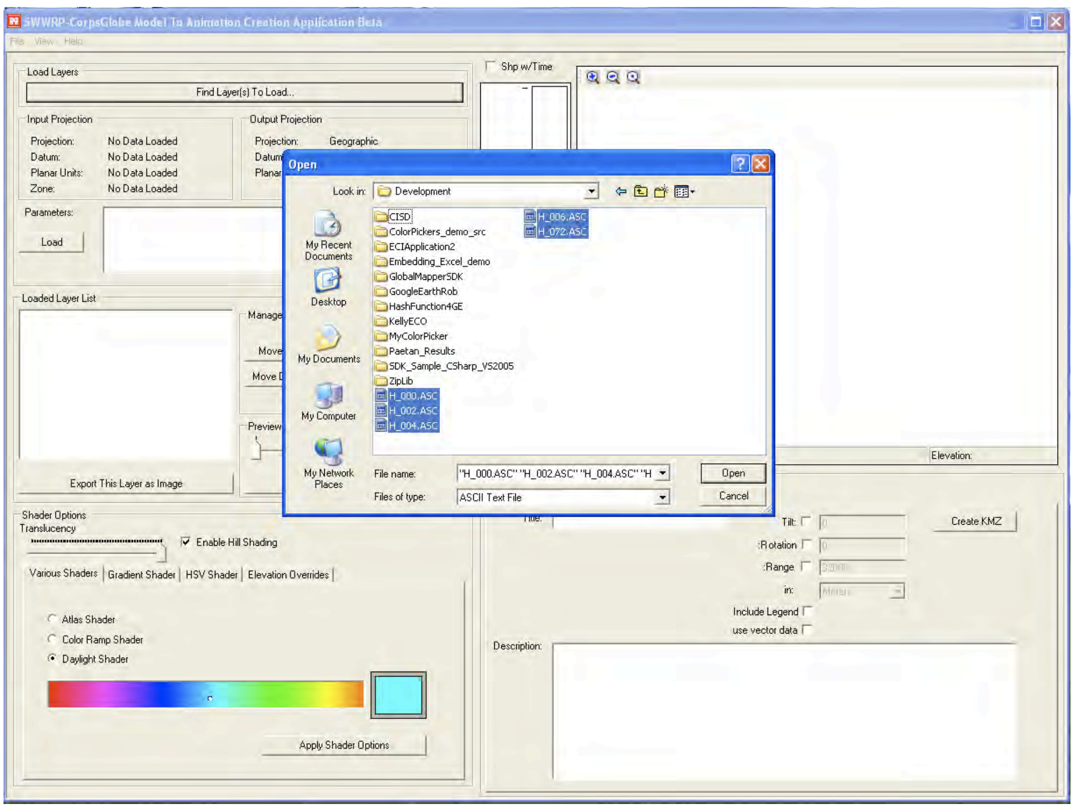


Figure C2. Select layers to open.

Once users have found the layers they want to load, they can select them and click open. Layers do not have to be opened one at a time; users can simply hold the Control button down and click on any number of layers they would like to load. Ideally, each GRIDASCII file would have an associated “world” file, which contains projection information related to the coordinate plane of the data.

If no projection data are found in the directory of the files that are being uploaded, users will be prompted with a message. After clicking OK, the following screen appears. This screen gives users the option to choose the correct projection for the data being loaded.

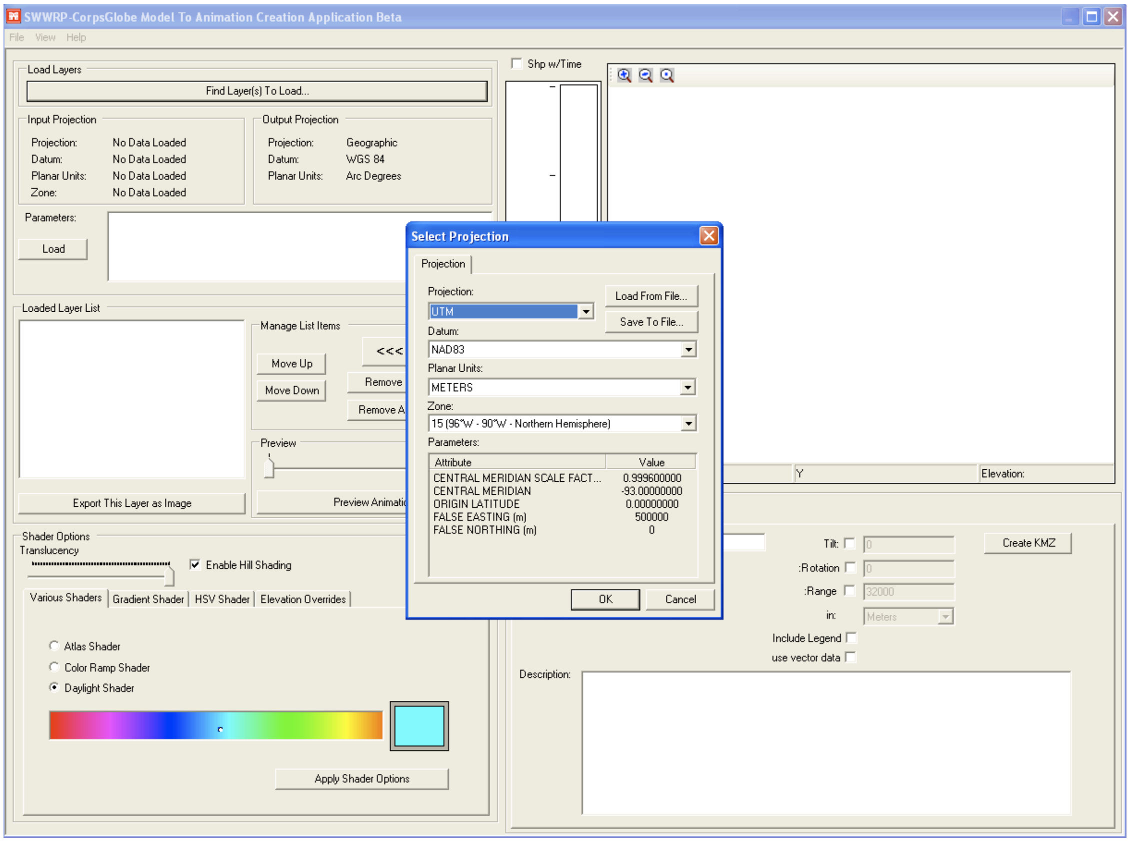


Figure C3. Choose a projection if none exists.

At this point the following screen appears, which shows the status of the files being loaded. As each file is finished loading, it shows up in the preview panel.

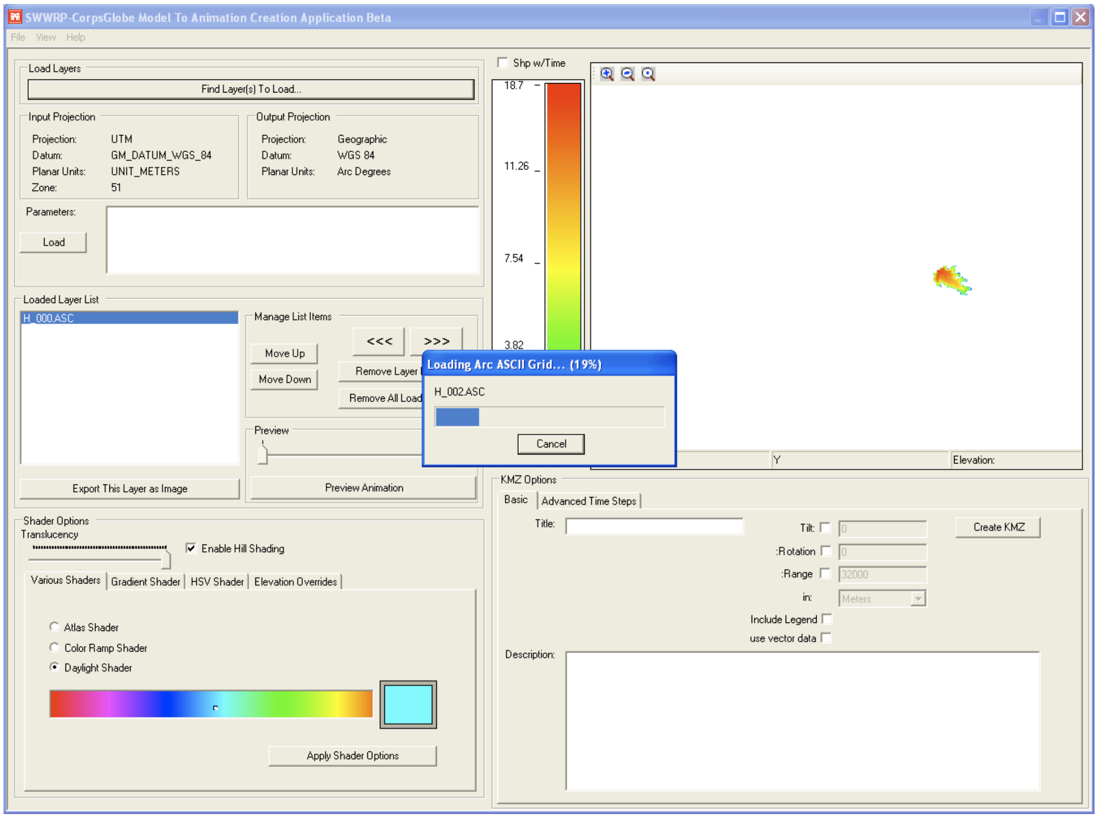


Figure C4. Opening the selected layers.

Once all files are loaded, a box appears that lists all of the layers that have just been loaded (See Figure C5). Clicking on these layers opens them in the preview panel.

If a user decides that the files were uploaded in the wrong order, layers can be rearranged by using the “move up” and “move down” buttons (see Figure C5). When the KMZ is created, the layers will be sequenced in time based on their order in this list.

For a rough preview of what an animation will look like, click the “preview” button (see Figure C5). This will cycle through all the layers that have been loaded and they will be drawn sequentially in the preview panel.

To delete a layer, users can simply click the “remove layer from list” button and the currently selected layer will be removed from the list (see Figure C5). To start over completely, users can click the “remove all loaded layers” button.

Another option at this point is to export a selected layer as an image. Click "Export This Layer as Image" and indicate where the file is to be saved. The only current option for exporting images is to a PNG file.

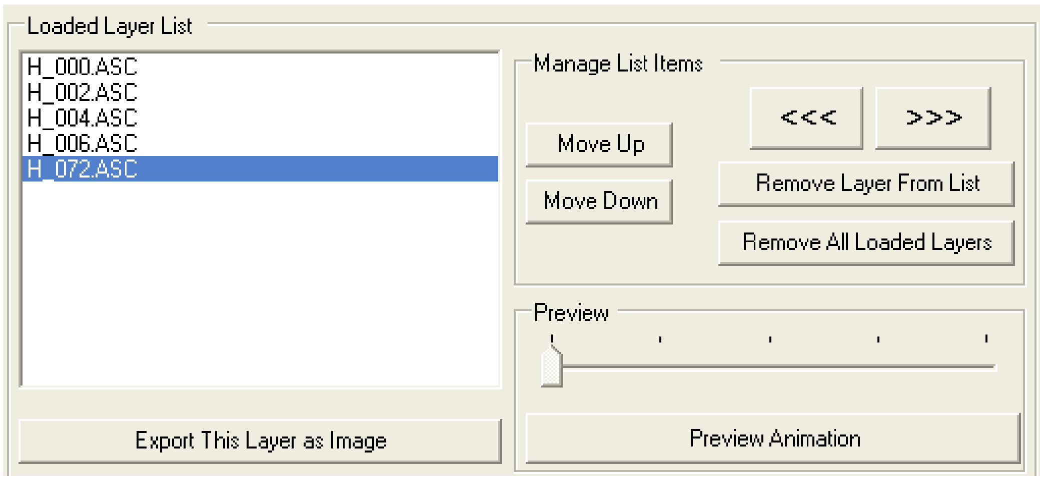
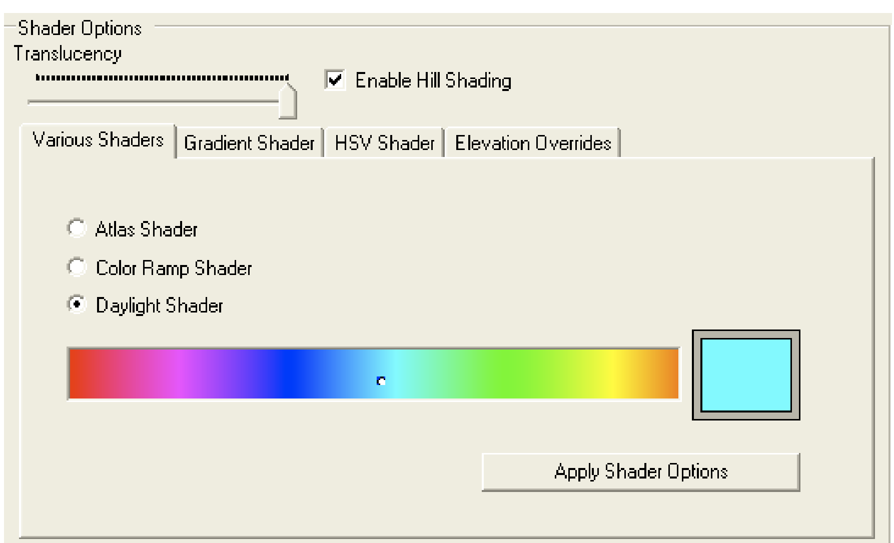


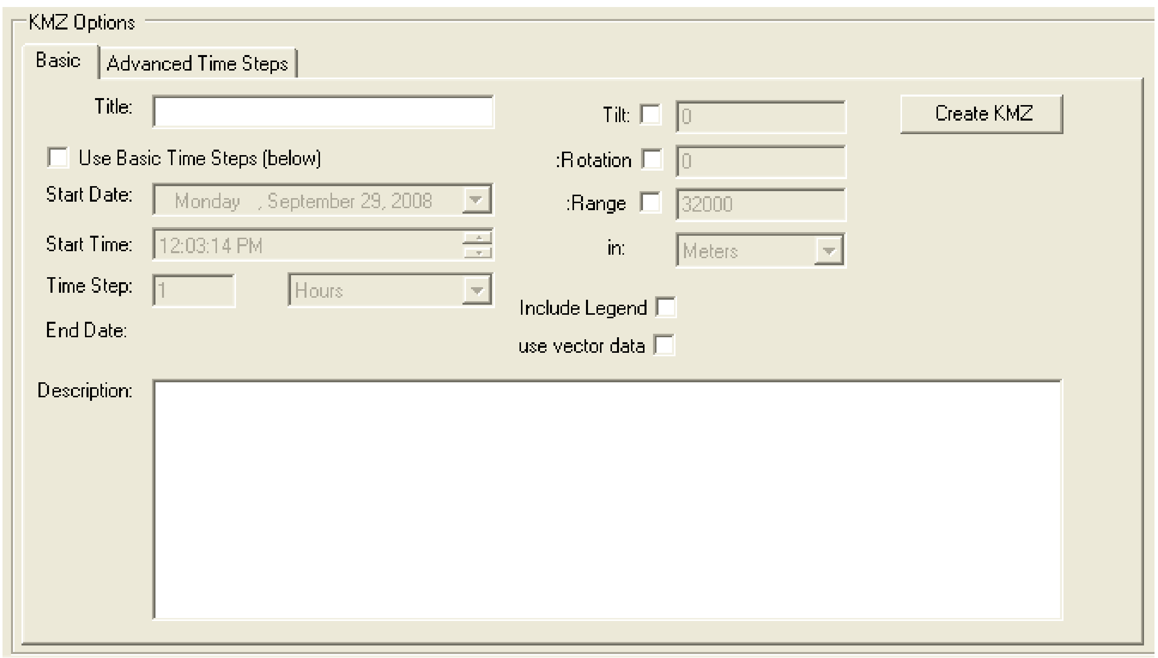
Figure C5. List of loaded layers and options to control layers.

The bottom left of the screen lists shading options. Users can apply different color schemes and transparencies to their layers. These changes are not specific to any one layer, but affect all layers that have been loaded. There are a wide variety of options for shading layers. Once a selection has been made, click "Apply Shader Options" to see changes.

Note: Currently the only file type that is known to work with the shader option is ASC files. Enabling this feature for other file types will be explored in future releases.



At this point users can begin specifying details they would like to insert into their KMZ file. The two main fields that must be filled in are “Title” and “Description.” To include the legend in the output, users need to check the “Include Legend” box. The “Use Vector Data” box is useful if layer data are coming from a file that has vector data, such as a shape file. If this box is not checked, an image will be created from what is seen in the preview window and this will be loaded as a ground overlay in GE. This is not ideal when vector data exist. So when using vector data, users should be sure to check this box.



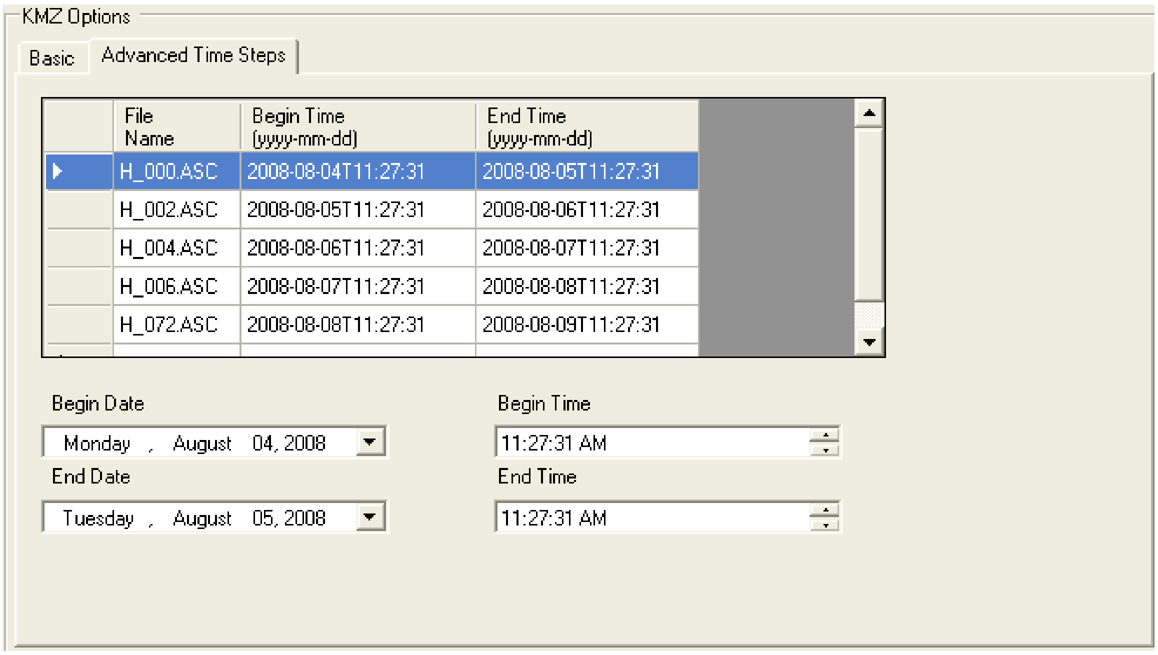
Note: If users check “Use Vector Data” and there are no vector data, the program could crash.

Users have a choice in defining the time at which each layer shows up. Constant time steps or variable time steps can be used.

To use constant time steps, users check the box labeled “Use Basic Time Steps.” This will enable the “Start Date,” “Start Time” and “Time Step” boxes. At this point, these boxes can be filled in as desired.

If varying time steps are needed between layers, leave “Use Basic Time Steps” unchecked. Click on the “Advanced Time Steps” tab under KMZ Options. This will provide a list of all the layers that have been loaded in the order that the user specified in the “Loaded Layers List” (see Figure C5). By

default these are all set to be one day apart starting with the current date. To change these, users highlight the row they are interested in and modify the date by using the combo boxes at the bottom of the screen.



Note: If two layers are set to overlap (one layer ends after the next layer begins), one of the affected rows will be highlighted in yellow. This is a signal to users that an overlap somewhere needs to be corrected.

Once choices for time steps have been made, users must verify that they are on the “Basic” tab under KMZ Options and click “Create KMZ.” Users will be asked where they want to save their file and can give it a name. Processing the request will then begin and users will soon have a KMZ file that they can open in Google Earth.

Note: If “use vector data” has been checked and the layer file has a lot of data, it will take a while to run the data. The program may appear to lock up, but it just takes much time to process the large dataset that has been submitted.

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14. ABSTRACT

This report describes the Ecological Dynamics Simulation Model – Light model (EDYS-L) in terms of its function and how to use the model software. EDYS-L is designed to mechanistically simulate complex ecological dynamics across spatial scales ranging from square meters to landscape and watershed levels. Modules include climatic simulators, hydrology, soil profile, nutrient and contaminant cycles, plant community dynamics, herbivory, animal dynamics, management activities, and natural/anthropogenic disturbances. Designation of scenarios and management alternatives for each simulation run is conducted within a Microsoft Windows user interface. Outputs include graphical displays in this interface, as well as extensive tabular files for all ecosystem components.

15. SUBJECT TERMS

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